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In The Matter Of:

STEVEN R. ARCH v.
THE AMERICAN TOBACCO COMPANY INC.,

Jeffrey S. Gentry, Ph.D.
May 21, 1997

CONFIDENTIAL

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Original File jgentry.txt, 140 Pages
Min-U-Script® File ID: 1213021810

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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF PENNSYLVANIA
Civil Action No. 96CV-5903

STEVEN R. ARCH, WILLIAM BARNES, CLARAN McNALLY, CATHERINE POTTS, NORMA RODWELLER, BARBARA SALZMAN, EDWARD J. SLIVAK: and JOHN TEAGLE,

Plaintiffs,

Deposition of:

vs. JEFFERY S. GENTRY, Ph.D.

THE AMERICAN TOBACCO COMPANY, et al

Defendants.

TRANSCRIPT of testimony as taken by and before Elizabeth S. Girvan, Shorthand Reporter and Notary Public in and for the State of North Carolina, at the offices of Womble, Carlyle, Sandridge & Rice, 200 West Second Street, Suite 1600, Winston-Salem, North Carolina, on Wednesday, May 21, 1997, commencing at 9:30 in the forenoon.

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EXHIBITS

JEFFERY S. GENTRY, Ph.D.
having been first duly sworn, was examined and testified as follows:

DIRECT EXAMINATION
BY MR. LEE:

Q: May I have your name and your professional address, please.

A: My name is Jeffery Scott Gentry. And my work address is Bowman Gray Technical Center, R.J. Reynolds Tobacco Company, Winston-Salem, North Carolina 27102.

Q: And what is your - you're referred to as Dr. Gentry?

A: Most people refer to me as Jeff, but I have a Ph.D.

Q: Okay. Well, you don't look old enough to have a Ph.D. But tell us about it. What is your educational training and background?

A: My Ph.D. is in analytical chemistry. I obtained that in 1986. And my undergraduate training was in zoology.

Q: Okay. So biology and -

A: Zoology.

Q: Zoology.

A: Right.

Q: And chemistry. That's still a good combination. What was your dissertation in your Ph.D.?

A: The title escapes me right now. Anolyte sample introduction into direct current plasma atomic emission spectrometry.

Q: That will be on your CV, too, won't it, the listing of that?

A: Yes.

Q: Let's let late file Exhibit 1 be a CV, if you either update it, prepare it, or whatever.

MS. FORBES: We'll get it updated and get it to you in a reasonable time.

MR. LEE: Good.

BY MR. LEE:

Q: All right. Tell me more about what - have you done any other writings as published other than your dissertation?

A: I have an external peer-review journal publication that was a result of my graduate work. And I have a submitted article into a peer-review journal that's submitted.

Q: And what is the title of that?

A: Of the second?

Q: Uh-huh.

A: It has to do with the thermal stability of potassium carbonate. I don't recall the exact title.

Q: Tell me, Dr. Gentry, about your work history. After your Ph.D., with whom were you employed?

A: I came - I finished my Ph.D. on June 20th of 1986 and began work at Reynolds June 30th, 1986.

Q: And have been with them since that time?

A: That's right.

Q: So 11 years that you've been -

A: Going on 11 years.

Q: Going on 11 years.

MS. FORBES: And, Mr. Lee, just for the record, at this point, it might be appropriate - I want to state for the record that this deposition is going to be under the protective order that's been agreed to in the Arch case. And because of Dr. Gentry's work, we anticipate that we'll have some confidential and highly confidential materials to be designated. And we'll just go from there, since his work history has been with Reynolds.

MR. LEE: Yes. And I have signed one protective order, I know, my partner David Lee and I have, my law firm. And if we need to do any

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other protective order, we can certainly do that.
I'm on the pleadings up there with Arch.
MS. FORBES: Okay. And have you signed the protective order in Arch?
MR. DAVID LEE: Yes, I have also.
MS. FORBES: Thank you.
BY MR. LEE:
Q: All right. Tell me, what was your title then when you came with R.J. Reynolds in 1986?
A: Research and development chemist.
Q: And what were your duties as a research and development chemist?
A: It was in the area of cigarette design and performance and materials therefore.
Q: Who were some of the people that you worked with?
A: At what point in time?
Q: Initially, when you first came with them, who would have been your immediate supervisor?
A: My immediate supervisor when I first joined Reynolds was Mike Shannon.
Q: And at some stage, I'm sure you worked with David Townsend?
A: I currently work under David Townsend.
Q: Now - under him now?

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A: Yes.
Q: Okay. Was - who is T.L. Gentry? I know I have that name, and you indicated that you were not T.L. Gentry.
A: No, I'm not T.L. Gentry. That is Tom Gentry. I don't know what the middle initial stands for.
Q: Is Dr. Shannon still with RJR?
A: Mike Shannon is not still with RJR.
Q: Has your title changed since being a research and development chemist?
A: Since then, yes. I have had several promotions.
Q: And just run through the steps of them. What was the next one after initially being an R & D chemist?
A: I began as an R & D chemist. Was promoted to senior R & D chemist, senior staff R & D chemist. And then my current title is master scientist.
Q: Master scientist?
A: Yes.
Q: All right. What were your duties as just the research and development chemist?
A: Throughout my career?
Q: Yes. When you were - yes, when you initially went with RJR as R & D chemist, what were

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your duties?
A: My duties - I was in the area of cigarette design and performance, and I worked directly on the Premiere product.
Q: Okay. Was that Project Alpha?
A: Yes. That was a nomenclature for it.
Q: Did it ever - did it ever have any other code name other than Project Alpha, to your knowledge?
A: I have read other code names. I don't know if they're all completely accurate.
Q: What were some of the other code names for it?
A: I heard one that was called Spa, S-P-A.
Q: S-P-A.
A: Sitting here today, I can't recall another.
Q: Yeah. But you think there may have been some other -
A: There may have been.
Q: - code name for it. When did you first hear of Project Alpha itself, after coming with RJR?
A: The first day on the job, I heard about the particular Project Alpha since it was directly where I was going to be working.
Q: And who did you hear it from?

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A: I don't recall who may have been the first person.
Q: Uh-huh. Was that your understanding when you first came in as an R & D chemist, that you would be working on Project Alpha, or how was it put to you?
A: No. When I interviewed, there was no indication the specifics of the project or the nature of the work, for that matter. It was a highly secret project at that point in time for competitive reasons, and I was not informed prior to my employment.
Q: Okay. Did you enter into any confidential agreements as part of your employment when you were employed by them?
A: I believe I did enter into - I'm not sure what the names of them are. Maybe a noncompete agreement.
Q: Yeah, probably.
A: And I believe there was an agreement on patents.
Q: Uh-huh. Do you hold any patents yourself?
A: I'm sorry?
Q: Do you hold any patents yourself?
A: Yes, I do.

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Q: And what are they in?
A: Many are in the areas of cigarette design, materials used in cigarette design, and particularly new technology-type products.
Q: Have you required those since coming with RJR?
A: Yes.
Q: And when you say "many," how many are there?
A: I haven't counted them.
Q: Again –
A: Ten or more.
Q: Again, would they be on your CV?
A: They are on my CV.
Q: They are on your CV?
A: Yes.
MR. LEE: At some stage – and maybe at the end of the deposition, Marilyn, I'll be mentioning that we reserve the right to continue with the witness if there's matters that I understand as being furnished to us this week on some voluminous documents that we might come across something that would pertain to Dr. Gentry that we may wish to come back. And the same way with the CV.
If there's any chance that during

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the noon hour that you could have it faxed to us here or something, I could see it, and that might help in touching those things, because to what extent the patents that he holds is important to this deposition is hard for me to say without knowing what they are.
MS. FORBES: Sure.
MR. LEE: And he says there are so many that he can't remember right off.
That's great. Congratulations.
THE WITNESS: Thank you.
MR. LEE: It's one thing to have a Ph.D. It's another thing to have as many patents that you can't name them all off.
BY MR. LEE:
Q: But mostly they're in cigarette design, are they not?
A: Right. And materials for it.
Q: And materials. Do you have any kind of an agreement with RJR that they're assigned to RJR or can't be used other than with RJR?
A: I believe there is assignment of my patents to RJR.
Q: That's not – to my knowledge, that's not unusual to have that kind of arrangement,

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particularly with a patent would come about during the employment with the company that might be closely related to the patent. In other words, they wouldn't want you to go out and start doing that patent with a company called Philip Morris probably, would they?
A: I would suppose not.
Q: Yeah. Okay. Now, after – how long did you work as an R & D chemist before being promoted to a senior research and development chemist?
A: Approximately two and a half years.
Q: And how did your duties change then with that, if they did change?
A: My overall duties did not change. The natures of the projects were changing at that time. But my overall duties in cigarette design, performance, materials development, did not change.
Q: Did you continue with Project Alpha then during that two and a half years?
A: The majority of that two and a half years, yes.
Q: How would you – how would you term Project Alpha yourself? When you heard that that was – that you were going to be working on that, what was your understanding that Project Alpha

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A: A cigarette in which the aerosol was a thermally generated aerosol. And that aerosol consisting primarily of glycerin.
Q: Okay. Did you understand why that you needed Project Alpha?
A: Initially, things were going very fast, and, no, I did not, other than it was a new product, a novel cigarette product, and was geared toward a number of consumer expectations or wants.
Q: All right. And were you told or did you have any understanding yourself of why that the consumer wanted this new product?
A: At what point in time?
Q: When you first came with RJR in 1986.
A: No. I was very naive in cigarettes, the whole area, so it really would not have even registered with me at that point.
Q: When you came with RJR in 1986, did you have an opinion yourself, Dr. Gentry, as to whether or not cigarettes were addictive, particularly addictive as defined by the Surgeon General of the United States or the DSM3 or any other category that you would have yourself?
MS. FORBES: Objection to the form.
You may answer.

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THE WITNESS: When I came with the company, I had never even thought about that particular aspect and certainly weren't aware of any of those definitions.

BY MR. LEE:

Q: Okay. So you had no opinion then when you came with them?
A: Not that I can recall.
Q: Have you ever been a smoker yourself?
A: I am a smoker.
Q: And you are now?
A: Yes.
Q: And how long have you been a smoker?
A: Eight years or so.
Q: What is your date of birth?
A: 11/3/57.
Q: So when you say eight years, so you've been smoking since you came with Reynolds, I guess, then?
A: Yes.
Q: That would be - so you started - you started - for eight years, so you started when, 1989?
A: '88, '89.
Q: '88, '89. Do you know of any statistics of a

person that doesn't start smoking until age 42, of what group you'd fall in?
A: No, I don't.
Q: Have you seen anything on that?
A: I may have seen something on it, but I certainly don't recall.
Q: If I were to suggest to you that 90 percent of the smokers started as a teenager, would that mean anything to you?
A: I have heard that said.
Q: And was there any particular thing that caused you to start smoking at age 42? And when I say age 42, that's about right, isn't it?
MR. DAVID LEE: 32.
MR. LEE: Age 32.
MS. FORBES: Objection to aging before your time.
THE WITNESS: These gray hairs have come in the last week and a half.
Could you restate the question.
MR. LEE: Read it back for me, Beth.

(PREVIOUS QUESTION READ BY REPORTER)

THE WITNESS: I don't know of anything specifically that caused me to start. I

don't know.

BY MR. LEE:

Q: That wasn't part of your employment contract, that you had to smoke?
A: Absolutely not.
Q: And what brand did you start smoking initially?
A: Premiere.
Q: And what brand - how long did you smoke Premiere?
A: Through its availability. I don't know what period of time that was.
Q: Assuming that it was through about '88 - well, how long was it available?
A: I don't recall specifically. It was available to employees of the research and development department longer than to the general public, than to the test markets.
Q: Okay. And when you first started smoking Premiere, do you recall any of your initial first reactions of when you first started smoking it?
A: Not that I can put a finger on, no.
Q: And how much did you initially smoke, like per day?
A: Initially, maybe two or three cigarettes.

Q: And then how long did that go on or occur?
A: How long did smoking two or three -
Q: Two or three cigarettes a day, uh-huh.
A: That was a ballpark. I don't know how long that went on.
Q: Okay. And, again, how long was - Premiere was - and Project Alpha was in when you had been in operation for some time before you came with them in 1986 obviously, hadn't it?
A: I'm sorry?
Q: I say Project Alpha had been an ongoing project before you came aboard in 1986. Do you know how long it had been in the making?
A: My understanding is that significant development work started in about 1982.
Q: And then went on until how long?
A: Premiere was introduced into test markets in the '88-'89 time frame and was removed from test market shortly thereafter. I don't recall the dates.
Q: So you started smoking them, two to three cigarettes a day. And did that progress, then, to a larger number, I take it, after a while?
A: Yes.
Q: And to what number did it get up to of just

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Premiere alone that you smoked?
A: Less than a pack. Between 10, 15 cigarettes -- probably.
Q: Okay. And then when it was taken off the market, is that when you quit then smoking Premieres?
A: No. They were available to the R & D employees, particularly people on that project, for longer than that.
Q: About how much longer?
A: I don't - I don't recall. Three or four years.
Q: And then you switched to some other cigarette, I take it?
A: There was a time when I didn't smoke at all.
Q: How long?
A: Maybe a year. These numbers are estimates. I have a hard time recalling those.
Q: And then you started smoking what cigarette?
A: I began smoking some Eclipse prototypes. And Eclipse is currently the brand that I smoke.
Q: Okay. So have you not smoked anything other than Premiere and Eclipse?
A: I have smoked other cigarettes, yes.
Q: And what were the others?

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A: I've tried a variety, many different types.
Q: Were they all RJR products, or did you -
A: No. I have tried others.
Q: What RJR products have you smoked?
A: I've tried a lot of them. I can't say that I've tried all of them, but I've certainly tried a number of them.
Q: Okay. Do you know how many brands that RJR has had since you've been with them that you have tried?
A: No, I don't.
Q: Winston? Salem? Carlton?
A: I've tried Winston. I've tried Salem. I've tried Vantage, Now.
Q: Camel?
A: Camel. Can't say that I've ever tried More. I've tried a variety.
Q: Were these all done in the nature of your work or just in your desire to smoke?
A: They were more done in curiosity of the taste of the cigarettes.
Q: Would you ever do any research reports on them, from the standpoint of the taste and your liking the cigarette, or however you would term it?
A: I have never done any taste reports.

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Q: That's not been part of your work then, has it?
A: I'm not sure what you mean by that, has not been part of my work.
Q: Okay. Well, in your smoking the different RJR products - Camel, Vantage, Winston, Salem - would you in turn then write up any kind of report as to your experience with that cigarette?
A: No, I have not.
Q: All right. Other than RJR, what others have you smoked?
A: I've certainly tried our major competitor's Marlboro. And I'm sure there's others. Let's see. You've lost me. Virginia Slims. Marlboro is the major one that I can really recall right now.
Q: But Eclipse is your current cigarette you say?
A: Yes.
Q: And how long have you smoked Eclipse?
A: I smoked a number of prototypes through the development phase, and have smoked Eclipse as is on the test market in Chattanooga for - since the time that it was in the test market.
Q: And how long has that been?

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A: I don't recall the actual introduction date. Six to eight months. I'm not sure.
Q: Do you know Tom Grissom? Have you worked with Tom?
A: I've heard the name. I've never worked directly with him.
Q: Do you know -
A: I know he's public relations.
Q: And he's here in Winston-Salem, is he?
A: Yes, I believe his office -
Q: Was it his idea to do the test market in Chattanooga, or do you know?
A: I don't know.
Q: Do you know if he's from Chattanooga?
A: No.
Q: What is Tom's title?
A: I believe he is senior vice president or executive vice president, external affairs, or public relations.
Q: After coming with RJR and working as you have from a research and development chemist, after having initially smoked Premiere and then - while that was available and then getting into the conventional cigarettes, and now having the experience with the Eclipse, Dr. Gentry, have you

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an opinion as to whether or not cigarettes and their contents are addictive?
A: I am not an expert in the area of addiction. I'm not even sure I understand the scientific or legal definitions of addiction. I do have a personal opinion.
Q: What is that opinion?
A: My personal opinion is that cigarettes are not addictive.
Q: And what do you base that on?
A: It's a personal opinion that I believe people can quit smoking if they so choose and are motivated to do so.
Q: And how about in your work and your understanding of cigarettes, have you come across or have any opinion as to whether any human disease is caused by cigarette smoke or contents of cigarette smoke or the consumption of cigarettes by a consumer?
A: I'm sorry. Could you break that down some?
Q: All right. Let me break it down to, first: Have you an opinion as to whether any human disease is caused by cigarette smoke?
A: I am not an expert in causation. I have read a number of things and have formed a personal

opinion.
Q: And what things have you read to help you on your personal opinion?
A: A variety of literature articles through the years. Articles by Wynder and Hoffman, the Froggat Commission Reports, a number - a number of different type of literature articles.
Q: Dr. Richard Doll, have you read any of his research?
MS. FORBES: Do you mean Richard Doll?
MR. LEE: Doll. I never know whether it's Doll or Doll.
MS. FORBES: I think he pronounces it Doll.
MR. LEE: D-O-L-L.
THE WITNESS: I know who he is, but I don't know if I specifically read any of his reports.
BY MR. LEE:
Q: How about Dr. Alton Ochsner?
A: Never read any of his.
Q: Or Mack DeBakey?
A: Never.
Q: How about Allen Rodgman, have you ever come

across that name with RJR?
A: I heard that name, yes.
Q: Do you know him? Have you ever met him?
A: No, I haven't.
Q: Have you read any of his stuff then?
A: No, I haven't.
Q: Where would you have read these things? At the RJR research library or -
A: Many I requested through the RJR library, yes.
Q: And have you had an occasion to use the RJR library yourself?
A: I've used it extensively over the years.
Q: And is that something that you would use in part of your work as a research and development chemist?
A: In the initial days as a research and development chemist on Project Alpha or Premiere, there was very few things pertinent in our library to my work there. So as a research and development chemist during the early days of my employment, there was not that much use of the library.
Q: Tell me a little about the library itself. It's located in the Bowman Gray Technical Facility, is it?

A: Yes, it is.
Q: And that's where you work and where you're employed, isn't it?
A: Yes.
Q: What all would the library contain?
A: A lot of books, a lot of journals, newspapers, a lot of it dealing with smoking, tobacco, tobacco science, chemistry, analytical chemistry, inorganic chemistry, toxicology, a variety of fields.
Q: Yeah. It would have - well, it would have any and all disciplines in which you'd be involved in as a research and development chemist, would it not?
MS. FORBES: Objection to the form. You may answer.
THE WITNESS: I'm not sure I understood your question.
BY MR. LEE:
Q: About how many volumes do you think it would have?
A: I don't have any idea.
Q: During your work, have you ever come across Dr. Robert DiMarco? Did you know him?
A: Yes.

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Q: How long did you work with him?
A: Dr. DiMarco was vice president of R & D when I initially joined R.J. Reynolds, and I don't remember the date of his retirement. I never worked directly for him. He was vice president of R & D.
Q: All right. If you came there in '86, how long do you think he was there after you came with them?
A: I believe he retired 1992. I'm not sure of those dates.
Q: He was one of RJR's representatives on the Council for Tobacco Research. Did you have any contact with the CTR, the Council for Tobacco Research?
MS. FORBES: Objection to the form.
THE WITNESS: I don't know what the Council for Tobacco Research is. I don't know whether he was a member of that or not.
BY MR. LEE:
Q: Yeah, he was a member, as I understand, a representative of RJR Corporation on it for a while. I don't know how long.
A: I don't know.
Q: But you're not familiar with that group

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itself, then, yourself?
A: No.
Q: Did you ever hear of the Tobacco Industry Research Committee?
A: I may have read or heard. I can't recall that specifically, no.
Q: It was a forerunner to the Council for Tobacco Research?
MS. FORBES: Objection to the form.
BY MR. LEE:
Q: How often would you get to the library itself, Dr. Gentry?
A: That varies considerably, depending on the nature of the work that I'm doing. At minimum, monthly.
Q: But it's located within the research and development facility there at Bowman Gray Technical Facility where you work?
A: Yes, it is.
Q: So it's used by not only you, but it's used by other research and development chemists in their work and probably utilized in Project Alpha, would it be?
A: It's certainly available to anyone in research and development. I don't know how many

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people used it that worked on Alpha or any other project.
Q: Okay. What is your opinion, then, as to whether or not any human diseases are caused by cigarette smoke?
A: As I said, I'm not an expert in the area of causation. I've read a number of things and formed a personal opinion. My personal opinion is that smoking associated with disease is not proven, it's not disproven. It falls in the area of unproven. And that's my personal opinion on it.
Q: Okay. Now, did that personal opinion - that's what you hold today here - what is this, May the 20th - 21st, I guess, 1997?
A: Yes.
Q: The RJR library would have a lot of articles relative to the question of human disease being caused by cigarette smoking, would it not?
A: The R & D library certainly has a lot of material that addresses or speaks to the risk associated with smoking and human disease.
Q: Probably has all of the Surgeon General Reports.
MS. FORBES: Object to the form of the question.

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THE WITNESS: I haven't specifically looked.
BY MR. LEE:
Q: Have you ever looked at a Surgeon General's report?
A: I've looked at some of them.
Q: Have you ever opened one up and read it?
A: Not the entire report, no.
Q: Any part of it? The introduction?
A: I don't recall specifically. I have read parts of Surgeon General's reports, yes.
Q: Have you ever read the part where the Surgeon General says 418,000 people a year die from cigarette smoking?
A: I never read that specifically, I don't believe.
Q: Have you ever read any figure that the Surgeon General says dies from cigarette smoking?
A: I read a lot of figures. I don't tend to store figures in my mind.
Q: Okay. How about secondhand smoke, do you have an opinion as to whether or not environmental tobacco smoke, ETS, or secondhand smoke causes any human disease from ingesting the secondhand smoke or the environmental tobacco smoke?

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MS. FORBES: Objection to the form.

THE WITNESS: Once again, I'm not an expert in causation of environmental tobacco smoke, so it would only be a personal opinion.

BY MR. LEE:

Q: And what is that personal opinion?

A: In my personal opinion, the arguments for environmental tobacco smoke are weaker than those for mainstream smoke. And my personal opinion would be that it's not proven.

Q: Okay. Now, if I, just without a court order or anything, just off the street, were to want to go to the library at the Bowman Gray Technical Facility, would that be possible, or how is that from the standpoint of the public visiting the library?

A: I don't know. I don't work in the library. I don't know what that policy is. We do have a security policy in the Bowman Gray Technical Center and, in fact, all of our complexes within the tobacco company.

Q: Yeah. So it would be whatever those policies are. But when you go to it, you have free access to it, do you not?

A: Yes, I do.

Q: In fact, who would be in charge of or head of the libraries at the Bowman Gray Technical Facility that we're talking about now? Who would be the person - would that be under Dr. Townsend?

A: No, it would not.

Q: Who would it be under?

A: I believe that particular area falls under Janet Wheeler.

Q: Janet Wheeler?

A: Wheeler.

Q: And what is her title?

A: I don't know for sure. Director or vice president of administration. I'm not really sure.

Q: The library has - is probably fully computerized, is it not?

MS. FORBES: Objection to the form.

THE WITNESS: I don't know if it's fully computerized. I use it a lot and request articles through many of the people that work in there. I don't know a lot about the specifics of its operation.

BY MR. LEE:

Q: Well, you utilize the computers in your research, do you not?

A: Yes, sir, I do.

Q: And do you ever utilize a computer and call in that stuff at the research library?

A: We have the ability at our desk to research journal articles, books, et cetera, that may have been entered into that system. I don't know whether that's inclusive.

Q: Well, for instance, on your - in your office itself, you have a computer program that you can access into the library, do you not?

A: Yes, I do.

Q: So you could call up, if you wished to do that, from the library and get any articles from any journals that might discuss the diseases which smoking is associated with, could you not?

A: I could certainly use the program or software at my computer top to research key words, authors, titles, to find if they were available in the library. And if they're not, then I could either request them or go find them.

Q: And that capacity has been there since you have been with RJR in the past 10 or 11 years, isn't it?

A: I don't know whether that capacity has been there or not.

Q: Dr. Gentry, did you have occasion to review

anything before coming to this deposition, in preparation for the deposition?

A: I've read a number of things over the years. In specific preparation for this deposition, I've read a number of things, glanced at a number of things, yes.

Q: And what would be some of those?

A: I have read some literature -

MS. FORBES: Objection to form. Just so the record is clear, are you talking about things that he's read over the years, or what is it you're talking about?

MR. LEE: Yes, as he indicated, that he's read some things in preparation for this deposition, and it sounded like it would be over the years.

MS. FORBES: I just wanted it to be clear.

MR. LEE: I'm asking what were some of those.

THE WITNESS: So, is the question in preparation for the deposition or over the years?

MR. LEE: No, in preparation for the deposition.

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THE WITNESS: In preparation for the deposition I read an article or two by Drs. Wynder and Hoffman, an article by Thomas Shelling, an article by Drs. Robinson and Pritchard, the Froggat Commission Report. I believe it was the fourth report.

BY MR. LEE:

Q: How do you spell Froggat?
A: I'm a terrible speller. F-R-O-G-G-A-T.
Q: Yes, something like that. Okay. Would it - I mentioned earlier the Allen Rodgman person. In your reviewing, writings, or whatever, did you come across any memos from him at all?
A: No, I have not.
Q: Now, I sort of left off after your senior R & D promotion to senior staff research and development chemist. What were your duties when that promotion came about?
A: Once again, it was in the area of cigarette design, performance, materials development for cigarettes and new products. The projects were changing, but the overall basic responsibilities weren't.
Q: You continued with Project Alpha or Project Spa - which did you call it, Project Alpha or

Project Spa?
A: I'd like to clarify. When I was a senior R & D chemist, I was not working on Project Alpha. I only worked on that project for roughly two and a half years.
In regard to what I called that project, most frequently, I guess I would have called it Project Alpha or Premiere.
Q: Okay. Do you know who assigned Project Alpha?
A: No, I don't.
MS. FORBES: Do you want to go off the record for a minute and take a quick break?
MR. LEE: Yes, that would be all right.
(RECESS TAKEN FROM 10:20 A.M. TO 10:28 A.M.)

BY MR. LEE:

Q: Have you ever had occasion to do your deposition before?
A: No. This is the first deposition that I've done.
Q: Okay. Now, what are the duties of a master scientist - first, how long have you been a master scientist?
A: I was promoted to master scientist in 1996, I

believe. And we have a number of master scientists in research and development. The duties vary.
Q: Is this under Dr. Townsend, then, as the master scientist?
A: My particular job is under Dr. Townsend, yes.
Q: How many Ph.D.s would there be under Dr. Townsend, if you know?
A: I don't know. I would only be guessing.
Q: What would that guess be?
A: It would only be a guess. But I would say on the order of 10 to 20, maybe. That's only a guess.
Q: Who are some of those that you work with?
A: I work directly with Dr. Chandra Banerjee, Dr. Mike Borgerding. I'll give you the easy names. Dr. Bob Lloyd. Those are the ones that come to mind right now. There may be others.
Q: Does any of your patents involve the spectrometer or any aspects of a spectrometer?
A: Spectrometer?
Q: Uh-huh.
A: No, they do not.
Q: What is that? What does a spectrometer do?
A: A spectrometer is a scientific instrument that quantitates or at least qualitates chemicals or compounds via light absorption, light emission,

light defraction, light fluorescence. There's a number of different types of spectrometry.
Q: Can you use that device to break out the constituents of smoke particles?
A: I'm not sure I know what you mean by can I use that device.
Q: Well, do you use that in your work?
A: I do not, no.
Q: Okay. During the 10 or 11 years that you've been with RJR and in the various capacities, have you worked with nicotine pretty much during that time?
MS. FORBES: Objection to the form.
THE WITNESS: I'm sorry. What do you mean "worked with nicotine pretty much"?

BY MR. LEE:

Q: Well, let's talk about nicotine. I'm going to give you just a plain sheet of paper and mark it Exhibit 2 so we know what we're talking about, and ask you to draw the atom nicotine for me, so we can talk about its properties and how it reacts with other substances, particularly levulanic acid or any of the others that we'll talk about. L-E-V-U-L-A-N-I-C. Is that the right spelling?
A: Levulanic? I'm not familiar with Levulanic.

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Levulinic.
Q: I could have it wrong.
Just draw the atom on Exhibit 2 there for me of nicotine.
MS. FORBES: Can you do that?
THE WITNESS: I'm not an organic chemist. Nicotine is a molecule.
Promise not to show this to my associates. I believe it to be something similar to that.
(DRAWING HANDED TO COUNSEL)
MR. LEE: Okay. We'll mark it later. I've marked it up in the corner, Exhibit 2.
BY MR. LEE:
Q: Levulanic acid, is that not a word that you're familiar with?
A: Levulanic acid is not a word that I'm familiar with.
Q: All right. What was the one that you said in lieu of that?
A: Levulinic.
Q: How do you spell it?
A: L-E-V-U-L-I-N-I-C.
Q: All right. Levulinic. I'm just pronouncing it wrong. I think I have the same word.

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What is levulinic acid? What is that?
A: It's an acid that I don't know the structure of or the chemistry of.
Q: Have you worked with it in your tobacco cigarette design in any way?
A: No, I have not.
Q: Do you know about it? Have you heard about it?
A: I've heard and read about levulinic acid, yes.
Q: Have you heard that it is used in cigarette design in any way?
A: In research around cigarettes and cigarette design, I have read that levulinic acid has been used in exploratory projects.
Q: In what way? Why do they use it?
A: There may have been a variety of ways. I'm not familiar with all of them since I haven't worked with it directly.
Q: What's your understanding of why it was used?
A: To my recollection, there may have been studies on various chemistries of it. I'm not sure what the question is.
Q: All right. The question is: Why is it used? What's the purpose of levulinic acid in use with

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nicotine or in cigarette design? Why is it used?
A: I would only be speculating. I've not worked with it. I've simply read some - I'm not even sure you would call them reports.
Q: That's reports within RJR that they have used it some?
A: Yes. Levulinic acid has been studied at R.J. Reynolds.
Q: Studied or used? That is, used with nicotine?
A: We do not use levulinic acid in any of our commercial products.
Q: Okay. But you only think it's been used as an experimental -
A: To my own knowledge, that's the only way we used it.
Q: And what did it do when it's used experimentally?
A: I don't understand what you mean by "what did it do."
Q: Well, if I suggest to you that it's used and it's used to act on the receptors in the brain to enhance nicotine, would that be anything that you'd recognize?
A: No, I would not. I'm certainly not an expert

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in receptors.
Q: All right. Have you studied or know anything about the neurotransmitters or the receptors of the brain and how nicotine acts on the receptors?
A: I'm not an expert and really do not know anything about that field.
Q: Uh-huh. Well, the - how about the use of ammonia, that would be something that would be within your field as a master scientist or in chemistry, would it not, Dr. Gentry?
MS. FORBES: Objection to the form.
You may answer.
THE WITNESS: Would you restate the question.
MR. LEE: Read it back.
(PREVIOUS QUESTION READ BY REPORTER)
THE WITNESS: I'm not sure how to answer that question. My area of expertise is in cigarette design and performance.
We have - I certainly know what ammonia is. And we've done research around ammonia or ammonia compounds.
MR. LEE: Okay.
THE WITNESS: I'm not sure how to answer your question.

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BY MR. LEE:
Q: Use the lower part of Exhibit 2, then, to help me with - have you worked with ammonia at all in any of your cigarette design work?
MS. FORBES: Objection to the form.
THE WITNESS: Not - I have not personally worked with any ammonia, to my best recollection.
BY MR. LEE:
Q: Is ammonia used in commercial cigarette products now of RJR products?
A: We do not use ammonia.
Q: At all?
A: Not ammonia in our commercial products.
Q: Do you use -
A: To my knowledge.
Q: Do you use any derivative of it, ammonia hydroxide or -
A: To my knowledge, in one of our reconstitution processes, there is the use of diammonium phosphate.
MS. FORBES: And again, Mr. Lee, just so the record is clear, ammonia, you know, is a natural constituent of tobacco. I just want to make sure we're clear about what we're talking

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about.
MR. LEE: I'm not clear about that.
BY MR. LEE:
Q: Is that your understanding, that ammonia is one of the natural constituents of tobacco?
A: It is a natural occurring constituent of tobacco.
Q: So ammonia is in the current tobacco product, then, I take it?
A: Ammonia is a naturally occurring constituent of tobacco, and it occurs in the smoke of cigarettes.
Q: Tell me how that works. When we talk about pH levels or the pH factor, ammonia would be a base, would it not, that would figure into that?
MS. FORBES: Objection to the form.
THE WITNESS: Ammonia is a base. But I don't know what you mean, tell you how it works.
BY MR. LEE:
Q: All right. How does it work, if you know? That is, what is a pH factor? Is there an optimum pH factor in cigarettes that you want to maintain or achieve?
A: I have no knowledge of an optimum pH

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factor.
Q: Do you not wish to achieve an optimum acid versus a base level as it would pertain to pH levels in smoke?
MS. FORBES: Object to the form.
BY MR. LEE:
Q: Is there such a concept as that?
A: Could you restate that question. I'm not sure I understand.
Q: Okay. How does - let me go about it this way: On a pH level, what would be your optimum on a pH level as it - as it pertains to tobacco smoke?
A: I don't know - I don't understand what the definition of optimum is or how you're using that. I don't know.
Q: Okay. I'm only using it - have you ever heard of free-basing nicotine?
A: I've heard it said. I don't know anything about it.
Q: Do you know anything about the tobacco companies, and particularly RJR, of free-basing nicotine?
A: I'm not sure what the definition of free-basing nicotine Is.

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Q: Well, to you, as a master scientist or a chemist, does free-basing have any indication or meaning to you at all?
A: I'm not an organic chemist and probably showing a lot of my ignorance in that area. I don't know exactly what that would mean.
Q: What's the difference in organic chemistry and the chemistry that you are in?
A: My Ph.D. was in analytic chemistry, specifically inorganic analytical chemistry. And the area that I work in now is cigarette design and performance, not in organic chemistry specifically.
Q: So when I mention to you free-basing - and I'm getting it from the term that Dr. David Kessler used in his 60 Minutes appearance that he talked about free-basing nicotine - if I can find it right fast, I'll quote exactly what he says - but that doesn't mean anything to you as an analytical chemist?
A: I've heard the term, but I don't know exactly what that means.
Q: In your cigarette design work, have you not attempted to get the optimum effect of nicotine for use by the person that consumes the cigarette?
MS. FORBES: Objection to the form.

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He's already testified –
THE WITNESS: Once again, I don't know what optimum means.
MR. LEE: Optimum to me means the desirable or the most effective or ideal –
MS. FORBES: Again, objection to the form. He's testified he doesn't understand the concept.
MR. LEE: Yeah.
BY MR. LEE:
Q: Have you seen any of David Kessler's appearances on 60 Minutes or any news programs where he's talked about the cigarette and what's happening?
A: I believe on occasion I have. I can't say that I've sat through them.
Q: Well, in your work, Dr. Gentry, do you not – do you ever work with the acid in the base of the chemicals that you're working with? Is that a concept that I'm just hung up on, or do you know what I'm talking about?
A: I'm not sure what concept you mean? Acid-based chemistry? I'm not sure what concept you mean.
Q: Well, when I say that you've got a pH level

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of 7, above or below that would be an acid or a base level, does that mean anything to you?
A: Yes, sir, it does.
Q: Pardon?
A: Yes, sir, it does.
Q: And how does that – just draw on that, if that would help in talking about it. Let 7 be your normal pH thing.
A: Seven is the middle of a pH scale. That's the normal.
Q: That's what I understand. So how does that work?
MS. FORBES: You want him to depict a pH scale?
MR. LEE: Yes.
MS. FORBES: Okay.
(WITNESS DRAWING)
BY MR. LEE:
Q: So you're going from 1 to 14, with 7 being the median.
A: Yeah, being in the middle.
Q: All right. Now, do you use that concept in working with your cigarette design at all?
A: No, I do not.
Q: Okay. Now, David Kessler talked about

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free-basing and was asked what does free-basing mean. And he said, answer: It's using certain chemicals to increase the potency of a drug.
So, have you ever done that or know of that being done by R.J. Reynolds?
A: No. That's the first time I've heard David Kessler say that.
Q: And that's not all of it. I need to read the rest of the answer.
Commissioner Kessler says: You know what free-basing is?
Stahl says: Yeah.
And then Kessler says: It's using certain chemicals to increase the potency of a drug. So, not only was there evidence of genetic manipulation, here was evidence for the first time of chemical manipulation.
You've not heard that then? And he's not talking about RJR. I think he's talking about Brown & Williamson.
A: No, I haven't heard that.
Q: So back on the drawing there, one being – that would be acidic, would it not, if it's one?
A: Yes.

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Q: And then 14 would be alkali, or how would you determine that?
A: Just base.
Q: Base. Now, that concept then of the pH of 7 or the median in it, you've not utilized at all in your work with cigarette design?
A: I do not use pH to design cigarettes.
Q: How would – do you say that you do not understand free-basing, or you don't know how that works?
A: I've testified that I don't really know the concept of free-basing. I certainly don't know how it works.
Q: Okay. Have you at any time attempted or done anything to make the potency of nicotine more effective?
A: I've never worked in the area of potency. I'm not sure what it really means. I don't know what making it more effective means.
Q: Okay. On Exhibit 2, the upper part of that, you've drawn the molecule nicotine. Do you consider nicotine to be a drug?
A: I don't know. I haven't thought about specifically nicotine as a drug. What do you mean, as a drug?

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Q: What is your understanding of what a drug is?
A: I'm not an organic chemist or a druggist, but my naive interpretation of what a drug would be would be something that has a pharmacological or physiological effect.
Q: Okay. Does nicotine have a pharmacological or physiological effect?
A: I've read that it does.
Q: So would that not make it a drug?
A: In the context of my reading that nicotine has a pharmacological and physiological response, in my personal definition, yes, it would.
Q: Have you ever used Freon 11?
A: Have I ever used Freon 11?
Q: Uh-huh.
A: No, sir, I have not.
Q: Have you ever heard of it being used in cigarettes?
A: I've heard that Freon was used. I'm not certain whether it was Freon 11.
Q: Is that Freon used within RJR's products?
A: Freon - and I'm not sure whether it was an 11 - was used at one time as an expansion agent for tobacco.
Q: What do you mean by that?

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A: By expansion?
Q: Yes.
A: Expansion is a process in which the tobacco is expanded such that it occupies more volume at a given weight. And that allows us to reduce the weight of tobacco used in cigarettes.
Q: To what extent have you worked with Dr. David Townsend? That is, would your work entail discussions with him relative to tar and nicotine?
A: I've had numerous discussions with Dr. Townsend. Some of them have been related to tar and nicotine.
Q: Dr. Gentry, in those discussions, has it ever involved whether Reynolds has adjusted tar, nicotine - intentionally gone in and adjusted tar and nicotine ratios with respect to any commercial cigarette in the United States whether it was patented or not?
MS. FORBES: Object to the form.
THE WITNESS: Could you break that down. I can't follow it.
MR. LEE: Let me have it read back, and if we need to break it down, I will.
(PREVIOUS QUESTION READ BY REPORTER)
MS. FORBES: Do you understand the

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question?
THE WITNESS: No, I don't.
BY MR. LEE:
Q: Okay. What do you not understand about it?
I will break it down.
A: Yeah, I need it broken down.
Q: Has Reynolds ever adjusted tar in any of its commercial cigarette products in the United States, whether it's patented or not?
A: Absolutely. We've for 40 years adjusted tar, reducing tar to lower and lower levels.
Q: Okay. Has Reynolds ever adjusted nicotine, intentionally gone in and adjusted nicotine in its commercial products in the United States, whether it was patented or not?
A: Intentionally adjusted nicotine?
Q: Yes.
A: In commercial products. Not to my knowledge.
Q: All right. Same way as intentionally adjusted tar?
A: Yes, sir, we did.
Q: But you adjusted tar but not nicotine?
A: No. Nicotine and tar are very co-dependent on one another, simply as a function of the way cigarettes work. And the result of 40 or more

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years of work have been to reduce tar. And nicotine has by and large paralleled that reduction. That was not definitely an intention. It was a result of reducing tar.
Q: It was part of your work. I mean, did you intend to do that?
MS. FORBES: Objection to the form.
Intend to do what?
BY MR. LEE:
Q: That is, intend to adjust the tar and nicotine ratios, or did it just happen?
A: I didn't intend to. And I don't believe Reynolds has. They are correlated with each other.
Q: Okay. Let me ask it then in this concept: Has Reynolds adjusted tar or nicotine, that is, intentionally gone in and adjusted tar and nicotine ratios to any of its commercial products, in cigarettes?
A: As I stated, tar and nicotine are related through the - just performance of a cigarette, the way a cigarette works. And we have intentionally reduced tar over a number of years. Changing tar-to-nicotine ratios is nothing that I know of that we've done intentionally with respect to commercial products.

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Q: Well, it just happens or does it - when you say you hadn't - it happens, but you didn't intentionally mean to do that, or how are you determining that?
MS. FORBES: Objection.
THE WITNESS: It happens. What is "it"?
BY MR. LEE:
Q: That is, it, meaning the adjusted tar-nicotine ratios with respect to the commercial cigarette.
A: I don't know how to further answer the question. I've testified that tar and nicotine are correlated with each other through the way that a cigarette works. And we've intentionally reduced tar for a number of years.
Q: Would that likewise, then, reduce the nicotine ratio?
MS. FORBES: Objection to the form.
THE WITNESS: I'm not clear what you mean.
MS. FORBES: What do you mean by "nicotine ratio"?
BY MR. LEE:
Q: Well, if you reduce a tar, do you

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automatically then reduce the nicotine?
A: Tar and nicotine are highly correlated in cigarette smoke.
Q: Can you reduce one without reducing the other?
A: From an experimental, on the lab bench, yes, that's technically possible. I don't know about the commercial feasibility or certainly consumer acceptance of any product in which that's been done.
Q: If you reduce the nicotine, do you automatically reduce the tar in a cigarette, in a commercial cigarette?
A: In a commercial cigarette, via the correlation between tar and nicotine, when tar is reduced, nicotine is concomitantly reduced.
Q: And is the reverse of that true, when nicotine is reduced, the tar is reduced?
A: Simply via the correlation between tar and nicotine that would be true.
Q: Do you intentionally do that? Have you intentionally done that in commercial cigarettes?
A: Intentionally done what?
Q: Reduce the tar and nicotine ratios irrespective whether it's a patented product or

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not?
MS. FORBES: Objection to the form.
THE WITNESS: I think I testified that we don't change the tar-to-nicotine ratio. They're highly correlated. We've reduced tar over a number of years. There's a range of tar-to-nicotine ratios in commercial cigarettes.
BY MR. LEE:
Q: What would be the reason or the purpose of reducing tar in a commercial cigarette?
A: There's actually been two reasons that R.J. Reynolds and the industry by and large has reduced tar. And one of those was consumer demand. And the other one was to address the allegations of the risk associated with cigarette smoking. And that risk being ascribed initially and, to my knowledge, even today, somewhat tied to tar.
Q: Why is that? What is happening when the - talk about risk in the tar?
MS. FORBES: Objection to the form.
THE WITNESS: I'm not sure what you mean.
BY MR. LEE:
Q: Well, you say that it's associated with - you're talking about the health aspects of

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cigarette smoke that associates tar as being harmful, are you not?
A: What I was speaking to was the literature which addresses and has said that the tar fraction of cigarette smoke has been associated with certain diseases. There have also been recent reports of whether gas phase or vapor phase was associated.
Q: And that's because of the carcinogenic compounds that's contained in the cigarette smoke, is it not?
A: Could you restate that.
Q: And that's because of the carcinogens or the carcinogenic compounds that's contained in cigarette smoke?
MS. FORBES: Objection to form.
THE WITNESS: I'm not sure what you mean by "that's because." What's "that"?
BY MR. LEE:
Q: That is the health risk.
A: The risk that people have ascribed to cigarette smoking is a statistical risk based on epidemiology. There have been researchers looking for 40 to 50 years for what may be in cigarette smoke that is associated with those risks. And to my knowledge, no one today even knows what those

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specific constituents are.
Q: That is, for 40 to 50 years there's been - how would you term it - research or allegations of health risks or harmful effects of cigarette smoke associated with smoking cigarettes?
A: Could you restate that.
Q: Yeah.
MR. LEE: Read that again.
(PREVIOUS QUESTION READ BY REPORTER)
A: There have been in the public media or via scientific literature allegations that associate cigarette smoking with various diseases, at risk for various diseases.
Q: And that's because of certain carcinogens, is it not, that's contained in cigarette smoke?
A: The associated risk that's ascribed to in the literature may have been looking for something to ascribe it to. Over those years of research, to my knowledge, no one knows what constituents in cigarette smoke are associated with those risks.
Q: Do you have any opinion yourself, Dr. Gentry, as to whether there's any carcinogens in cigarette smoke that's associated with disease or the health aspects of cigarette smoke?
A: Your question has two parts. The first

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speaks to, are there constituents of smoke that have been identified at carcinogens. Yes, there are constituents of cigarette smoke that have been identified as carcinogens by various organizations. The second is whether they're associated with the risk of smoking. And I don't know that.
Q: What are those that you're talking about?
MS. FORBES: Objection to the form.
THE WITNESS: There are a lot of constituents in cigarette smoke. There are over 4,000 in the tar phase.
BY MR. LEE:
Q: And as a matter of fact, there's about 4,700, isn't there?
A: I don't know the specific number.
Q: What would be your best estimate of the number?
A: As I just said, in excess of 4,000 is the last I read as an estimate.
Q: And those carcinogenics - or those carcinogens have been associated, like you say, for 40 to 50 years, have they not?
MS. FORBES: Objection to form.
THE WITNESS: As I testified, there are a number of constituents of smoke that have

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been identified as carcinogens or labeled as carcinogens by various organizations. Over the 40 to 50 years of research, no one knows if any of those constituents are, in fact, associated with the risk of smoking.
MS. FORBES: Mr. Lee, while you're looking through that, let's just take a quick break.
MR. LEE: Let's do.
(RECESS TAKEN FROM 11:05 A.M. TO 11:15 A.M.)
BY MR. LEE:
Q: Dr. Gentry, before the break, we were talking about various things here. And I'm having a hard time understanding exactly what you do. Just what do you do?
A: My work day to day is in new product technology. It's in cigarette design, performance, and quite proudly, my work is geared toward the reduction of the chemical constituents in cigarette smoke.
Q: Have you been successful in reducing the components or the chemicals in cigarette smoke?
A: Relative to some other products, there's developments we've had that have reduced certain constituents in the smoke.

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Q: And what are they?
A: There's been a number of constituents that we've looked at and reduced.
Q: And what are some of those?
A: We've had - built prototypes, built cigarettes that have reduced many of the carbonyl compounds, acetaldehyde, formaldehyde, acrolein acetone, benzene. We've reduced benzene in a cigarette design. Tobacco-specific nitrosamines. There's been a number of them.
Q: Why were you taking those out? Why did you take those out?
A: We take very seriously the allegations that have been leveled against various constituents of cigarette smoke, whether we believe them or not or know them to be true. We take them very seriously. And we work very hard to address in a proactive manner those reductions of those constituents.
Q: And why is that? Why do you take those out?
A: As I said, we take the allegations -
MS. FORBES: Objection to the form.
THE WITNESS: We take those allegations very seriously.
BY MR. LEE:
Q: And those allegations are what?

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A: Allegations associated with the risk between smoking and disease.
Q: And that's an allegation that's been around for 40 or 50 years, has it not?
A: To my knowledge, I believe that to be correct.
Q: Have you been able to take benzo(a)pyrene out?
A: I have not had any experience specifically reducing benzo(a)pyrene.
Q: Have you tried to?
A: Have I tried to?
Q: Uh-huh. Or your department.
MS. FORBES: Objection to the form.
THE WITNESS: Over what period of time?
BY MR. LEE:
Q: Over any period of time.
A: It's my understanding that over a period of time, as various constituents have been identified in cigarette smoke and had allegations associated with smoking and the risk, that we have looked at various ways to reduce those particular constituents. Benzo(a)pyrene is one of those.
Q: And why would you want to get rid of

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benzo(a)pyrene?
A: As I stated, we take the allegations against constituents we've identified in cigarette smoke, we take those allegations very seriously, whether we know them to be true or not.
Q: Well, benzo(a)pyrene is one of those that's been identified as being a carcinogenic compound or carcinogenic to the extent that it reacts with the P53 gene to cause cancer, is it not?
MS. FORBES: Objection to the form.
THE WITNESS: I need to break that one down. Benzo(a)pyrene, to my knowledge, has been identified as a carcinogen, not necessarily a carcinogen in cigarette smoke. No one knows if that's the case. Associated with the -
BY MR. LEE:
Q: P53 gene.
A: I don't know.
Q: Do you know - have you heard about the P53 gene or do you know anything about it?
A: No.
Q: Have you heard that at all?
A: Not the P53 gene, no.
Q: All right. Benzo(a)pyrene, you say that's been recognized as being a carcinogen?

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A: There are several international organizations and the Surgeon General who have identified it as a carcinogen, benzo(a)pyrene, not necessary in cigarette smoke.
Q: Well, it's in other things, but it's also in cigarette smoke, is it not?
A: It's in a number of things, as well as in cigarette smoke.
Q: And it's in the cigarette smoke, the commercial products that RJR Tobacco Company manufactures, is it not?
A: Benzo(a)pyrene is not an additive to cigarettes. It's a natural constituent that's produced upon the burning or pyrolysis of tobacco. It's not something that's added to cigarettes. Benzo(a)pyrene, to my knowledge, is not a natural ingredient inherent to tobacco.
Q: You say it is not. It just happens when you have the combustion or the burning of it?
A: It's a result of combustion, is my knowledge.
Q: How is that? How does that work?
A: I don't know the chemistry of benzo(a)pyrene formation.
Q: Does your work involve studying any serology or blood work of any sort?

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A: No. My work - no.
Q: Does cigarette smoke contain any polycyclic hydrocarbons?
A: Yes. Polycyclic carbons have been identified in cigarette smoke.
Q: And how long have they been identified and recognized as being in cigarette smoke?
A: I don't specifically know.
Q: Certainly since the time that you've been with RJR, have they not?
A: I could only guess. I would venture that would be correct, but it's only a guess.
Q: Is it recognized as being a harmful compound?
MS. FORBES: Objection to the form.
THE WITNESS: I'm not sure what you mean by "harmful."
BY MR. LEE:
Q: Has it been identified as being carcinogenic?
MS. FORBES: Objection to the form.
Are you talking about the - what is "it"?
MR. LEE: What?
MS. FORBES: What is "it"?
MR. LEE: It. Polycyclic hydrocarbons.
THE WITNESS: Polycyclic

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hydrocarbons are a number of different compounds. That's just a class of compounds.

BY MR. LEE:

Q: Well, you recognize that they've been known to be carcinogenic to a mouse skin test, have you not?

MS. FORBES: Objection to the form.

THE WITNESS: I don't believe I recognize that.

BY MR. LEE:

Q: Well, have you taken part in any 90-day mouse skin studies yourself?

A: No. That is not under my responsibility.

Q: Who is that under? What would be the title of the person?

A: Title of the person that mouse skin painting -

Q: Yeah.

A: Dr. Don deBethizy.

Q: And what is his title?

A: I'll not sure whether he's a director or vice president -

Q: What is your -

A: - within R & D.

Q: In R & D?

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A: In R & D.

Q: Have you ever worked with him?

A: I've come in contact with him. I've never worked directly with him.

Q: Have you had the benefit of his studies and work?

A: I'm not sure what you mean by "benefit."

(BRIEF PAUSE)

BY MR. LEE:

Q: Let me have the spelling of his name. Help me on that.

A: DeBethizy?

Q: Uh-huh.

A: D-E-B-I-T-H (sic) -

Q: I-C-H?

A: I-T-H-E-Z-Y (sic). I hope I did him justice.

Q: And his first name?

A: Don.

Q: Don. Okay. So the work on the mouse studies would have been under his department?

A: I believe that mouse skin painting is under his department.

Q: What was the purpose of those mouse skin paintings?

A: I don't know how many have been done nor the specific purposes of those studies.

Q: Do you know the results of them?

A: I can't say that I've seen them.

Q: Have you heard what the results were?

A: The results of what studies?

Q: The mouse skin painting studies.

A: There may have been a lot of mouse skin painting studies. I'm not sure what studies you're talking about.

Q: I'm talking about the ones done under Don deBethizy.

A: Uh-huh.

Q: Have you ever heard that they did confirm that carcinogens in cigarette smoke did cause cancer on the mouse skin studies?

A: I have not heard that.

Q: Not heard that. What have you heard about it?

A: I'm having a hard time understanding, what do you mean, what did I hear about it.

Q: That is about the studies that Don deBethizy did relative to putting recognized carcinogens as contained in cigarette smoke on mouse skin.

MS. FORBES: Objection to the form. You may answer.

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THE WITNESS: My understanding of the experiments is that condensate from cigarettes is painted onto the shaven backs of mice. So, it's cigarette smoke condensate that's painted on. I'm having trouble knowing where you want to go from there.

MS. FORBES: Do you know anything else?

BY MR. LEE:

Q: I just want to know what happened when they did that. What happened when they painted that on mouse skins and what happened then? Did anything adverse happen?

A: I don't know.

Q: Or did nothing happen? I mean, what's your understanding?

MS. FORBES: Objection to the form. He's testified he does not know.

MR. LEE: Okay.

BY MR. LEE:

Q: Have you talked to Don deBethizy about it - about that, about his work?

A: There's a lot of functions under Dr. deBethizy. Mouse skin painting is only one of the functions. And as far as I know, there's been

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a lot of mouse skin painting studies done. I'm not sure what specifically you're trying to get in this whole line of questioning.

Q: I mean, I've heard from documents, or from whatever, that when you had those mouse skin paintings of cigarette condensate, that it did cause cancer to form, abnormal cell structure that's identified with adverse effects. Have you not ever heard that?

A: Oh, I've heard that, yeah. And to my knowledge, there have been experiments which show tumor growth as a result of painting condensate from cigarette smoke on the backs of mice.

MS. FORBES: Again, objection to the form. Just to make sure the record is clear, are you talking - you're talking about you heard it generally in the public domain; you are not familiar with Dr. deBethizy's research. Is that correct?

THE WITNESS: The problem I'm having with Dr. deBethizy's research is what specific experiments. I mean, there's been several that I would -

BY MR. LEE:

Q: There's been a lot of them?

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A: I would conjecture there have been. I don't know.

Q: The one that I'm talking about is just simply that when you put smoke condensate that would contain some of the recognized carcinogens in cigarette smoke on the back of a mouse, that it would cause tumor or abnormal growth.

A: I have read or seen that painting cigarette smoke condensate on the backs of mice at various concentrations produces tumors.

Q: And those tumors, those are cancerous tumors, are they not?

MS. FORBES: Objection to form.

THE WITNESS: I'm not an expert in that area. I don't know what -

BY MR. LEE:

Q: Well, malignant - malignant tumors. They weren't benign tumors, were they?

A: I really don't know.

Q: Did you ever ask whether they were malignant or benign?

A: No, I haven't.

MS. FORBES: And again, I think the record is a little confused. I just want to make sure you're talking about what you have read,

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public domain. Is that correct?

THE WITNESS: I have read in the public domain and - the problem I'm having with Dr. Don deBethizy is what studies you're talking about.

BY MR. LEE:

Q: And those that you've read were studies of smoke condensate on the backs of mice or mouse skin and that that smoke condensate did cause tumor growth?

A: Could you restate that.

MR. LEE: All right. Read it back to him.

(PREVIOUS QUESTION READ BY REPORTER)

THE WITNESS: I'm sorry. Could you please read that again.

(PREVIOUS QUESTION READ BY REPORTER)

THE WITNESS: Yes, that's my understanding of what I've read.

BY MR. LEE:

Q: We were talking about the polycyclic hydrocarbons. Also there's the heterocyclic nitrogen compounds that's identified as carcinogens in cigarette smoke, is there not?

A: Heterocyclic?

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Q: Yes.

A: Nitrogen compounds?

Q: Uh-huh.

A: Could you restate the question.

(PREVIOUS QUESTION READ BY REPORTER)

To my knowledge, there are polycyclics or heterocyclic nitrogen compounds in cigarette smoke. I don't know if they've been identified as carcinogens in mouse skin painting tests.

Q: Have you ever attempted to take them out of cigarette smoke?

A: The heterocyclic nitrogen compounds?

Q: Yes.

A: Yes, I have, as relates to particularly two compounds.

Q: And were you successful in taking them out then?

A: Unfortunately, we have not been yet. I have not been.

Q: Why were you trying to take them out?

A: The two particular compounds that I was looking at were identified as bladder carcinogens. And just via the association of being in smoke and identified, I took - those are allegations that we take very seriously.

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Q: Now, of the hydrocarbons, would include benzoanthrosene? Do you recognize that?

A: I'm sorry?

Q: The hydrocarbons that we were talking about would include ben - B-E-N-Z, anthracene, A-N-T-R-A-C-E-N-E.

A: Benzoanthracene?

Q: Yes.

A: I believe that is a polycyclic aromatic hydrocarbon.

Q: That's been recognized as being carcinogenic, is it not?

A: I don't know about that specifically.

Q: You don't have an opinion one way or the other?

A: No, I don't. I don't know if that's been identified as a carcinogen.

Q: But you do recognize that benzo(a)pyrene has been identified, probably, this back 40 to 50 years that we were talking about earlier?

A: I believe benzo(a)pyrene -

MS. FORBES: Objection to the form.

THE WITNESS: - has been identified in cigarette smoke. I don't know what period of time that was identified in. And has

been identified as a carcinogen by a number of organizations.

BY MR. LEE:

Q: Well, the phenols and fatty acids are also carcinogenic agents identified in cigarette smoke, are they not?

MS. FORBES: Objection to the form.

THE WITNESS: I don't know that they're identified as carcinogens in cigarette smoke. What I have seen is that phenol has been identified as a co-carcinogen in some biological assay. I don't know what biological assay.

And what other compounds are you talking about?

MR. LEE: Fatty acids.

THE WITNESS: I don't know about fatty acids.

BY MR. LEE:

Q: Do you know whether they are in cigarette smoke or not?

A: I'm not sure what the - what compounds fatty acids includes.

Q: I don't know either.

A: Sorry.

Q: So you don't know whether, though, they're

identified in cigarette smoke, that is, fatty acids?

A: What I know is that there are fatty acids contained in tobacco. And I don't know specifically what those fatty acids are.

Q: When you testified earlier that cigarette smoke does contain 4,000 or more, would that be a fair statement, of chemical compounds?

A: Cigarette smoke in the particulate phase, it's been identified or postulated to be over - or estimated to be over 4,000 chemical constituents in the particulate phase of cigarette smoke.

Q: How many of those would be added by the tobacco company in the manufacture of the cigarette?

A: I don't know what you mean by "added by."

Q: Added to or as additives. I mean, that's not 4,000 natural chemical compounds, would it be?

A: Cigarette smoke is comprised of a variety of chemical constituents. Some are directly transferred from the tobacco matrix. Some are pyrolyzed and the broken-down degradation products are transferred into cigarette smoke.

Some additives are probably transferred directly. I don't know how many may be, and I

certainly don't know a percentage of that 4,000.

Q: But do you recognize that some of the 4,000 would be additives? That is, some of the 4,000 chemical constituents would be additives or added to the natural smoke compound?

A: I would speculate that of those 4,000 or more constituents in the particulate phase, that some may be additives.

Q: Do you have any opinion yourself, Dr. Gentry, whether cigarette smoking contributes to a shortened life span of the smoker?

A: I'm sorry. Could you -

Q: Do you have any opinion, yourself, Dr. Gentry, as to whether cigarette smoking shortens the life span of the smoker?

A: I'm not an expert in the medical field. All I can possibly offer would be a personal opinion.

Q: And what is that personal opinion?

A: My personal opinion is that disease, death is such a complex multifactorial thing, that I don't know how one would go about distinguishing how many years are cut off of a life. I honestly don't know. I'm not an expert, and I don't know how you would estimate that number.

Q: Well, that's done through mortality tables

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and studies of the individuals, is it not? Isn't there recognized entities that do that such as the Center for Disease Control in Atlanta does that work, do they not?
MS. FORBES: Objection to the form.
THE WITNESS: Could you break that into separate questions?
BY MR. LEE:
Q: You said that you don't know who does that type of work to determine whether or not –
A: I believe I said I don't know how that would be done.
Q: How. Okay. When I mention the Center for Disease Control out of Atlanta, do you know who I'm talking about?
A: I know about the Centers for Disease Control.
Q: And that would be the type of work that they would do, would it not?
MS. FORBES: Objection to the form.
If you know.
THE WITNESS: I don't know.
BY MR. LEE:
Q: Now, we were talking about just what you did. And you told me – I don't remember all the things you told me. But what is reconstituted tobacco?

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A: Reconstituted tobacco is a tobacco that is made by a process in which small particles that are not useful for inclusion in cigarettes are processed such that they can be made into a paper-like sheet, which is then cut, and can be used in cigarette production in the appropriate size.
Q: Did you use that in Project Alpha or the development of the Premiere cigarette?
A: Did we use reconstituted tobacco?
Q: Yes.
A: In one of the components, reconstituted tobacco was used.
Q: And did you have any side effects of that?
A: I don't know what you mean by "side effects."
Q: Well, any adverse side effects?
A: I don't know what you mean by "adverse side effects."
(DISCUSSION OFF THE RECORD)
MS. FORBES: Do you all want to go out for a minute?
MR. LEE: No. I'm going to go a little more and then we'll look at these at lunch.
MS. FORBES: Just on the record, the patents have been provided about 11:30, and

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give them a chance to review them over the lunch. Do you want to break about twelve for lunch?
MR. LEE: Yeah, we will. We'll go about another 10 or 15 minutes, and then we'll break for lunch.
BY MR. LEE:
Q: Is the use of ammonia utilized in the reconstitution of tobacco?
A: As I testified, I believe we use diammonium phosphate in the formulation of one of our reconstituted sheets.
Q: And why do you do that? What's the purpose of doing that?
A: I'm not an expert in reconstitution. The knowledge that I have is that it helps in the pectin release, the natural pectins that occur in tobacco to help bind the sheet together. And I believe there's been some consumer studies done where it may improve the taste of the cigarette.
Q: What is pectrin? I'm not familiar with that. What do you mean by that?
A: Pectin?
Q: Pectin.
A: Pectin is a naturally occurring constituent of tobacco. It's in fruits. It's – in the

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context of tobacco and in the reconstituted process, it's actually a complex carbohydrate that can be used to begin to bind fibers together.
Q: Now, basically, what is the difference in the Premiere and the Eclipse cigarette?
A: I haven't worked directly on Eclipse. I don't know a lot of the specifics. I did work a lot on Premiere. There's a number of differences between the two cigarettes.
Q: Each of them have reduced tar, do they not?
A: By measurements under normal smoking conditions, they have reduced tar.
Q: And each have – with the tar ratio of nicotine being as you've indicated earlier, sort of go hand in hand, would have reduced nicotine, would they not? If they have a reduced tar, they have a reduced nicotine?
A: When I was speaking earlier, I was speaking specifically to tobacco-burning cigarettes and did not really make the connection with Premiere and Eclipse. Off the top of my head, even the tar-to-nicotine ratio in Premiere and Eclipse would be similar to what you'd see in a conventional tobacco-burning cigarette.
Q: Why was that? Why would you want to do that?

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MS. FORBES: Objection to the form.
THE WITNESS: You imply that it was [illegible]
an intent. I don't know.
MR. LEE: I mean, of Premiere.
THE WITNESS: It wasn't an intent
of that design. Tar and nicotine ratio was not an
intent.
BY MR. LEE:
Q: Taking the Premiere separately, why would you
want to do that reduction? You –
A: What reduction?
Q: Reduction in tar and nicotine. Did you not
have a reduction in tar and nicotine in the
Premiere?
A: The smoke composition of Premiere was
drastically different than the smoke composition
from traditional tobacco-burning cigarettes. The
major constituent in the tar of Premiere was water
and glycerin.
Q: Which was reduced from the conventional
cigarette, was it not?
A: Actually, water and glycerin are
substantially increased in the smoke of Premiere
relative to traditional cigarettes.
Q: And that in turn has the effect of reducing

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the nicotine and tar, does it not?
A: I'm not sure I understand. I'm not sure I
understand.
Q: Are you saying water and glycerin are
increased in the Premiere and that, in turn, has
the effect of reducing the tar and nicotine, does
it not?
MS. FORBES: Objection to the form.
THE WITNESS: Water and glycerin
are substantially increased in the smoke from
Eclipse and Premiere relative to that of
traditional tobacco-burning cigarettes,
substantially.
What was the second part of the
question?
BY MR. LEE:
Q: And that is that when you increase the water
and glycerin, you automatically decrease the tar
and nicotine, do you not, in the Premiere
cigarette?
A: Tar, as defined by the method in which it was
measured, is the total wet particulate matter from
which you subtract water and nicotine. So I'm
not – I don't know the connection – I'm having a
hard time understanding the connection we're trying

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to make with these questions.
Q: Well, in the Premiere cigarette, if I just
asked you on the street, what is the difference in
the Premiere and the conventional cigarette, what
would you tell me?
A: Premiere was a tobacco-heating cigarette
rather than a tobacco-burning cigarette, and the
composition of the smoke from Premiere was
substantially different than that from
tobacco-burning cigarettes and produced very
little – virtually no sidestream smoke.
Q: And if I ask you as to whether – which of
the two would have lesser health risk, what would
you say?
A: I'm not an expert and couldn't
really – don't know how to make that assessment.
I can give a personal view or opinion on that.
Q: And what would that personal view or opinion
be?
A: Given the significant reductions in the
complexity of the chemical constituents in Premiere
relative to tobacco-burning cigarettes, I believe
that it is a product that represents one in which
the risk associated with smoking may be reduced.
Q: Why is that? Why would you say that?

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A: It's simply a personal opinion in which a
number of the chemical constituents that are in
traditional cigarettes have been significantly
reduced. I don't know that that represents a
reduction in risk, but that would be a speculation
I would make.
Q: What was Premiere's tar content?
A: What was Premiere's tar?
Q: Content.
A: Yield?
Q: Uh-huh. Yield.
A: I don't recall.
Q: In percentage to the conventional cigarette
or the average cigarette, what would it have been?
A: I believe Premiere was a low-tar or an
ultra-low-tar cigarette. We offer – just in the
market today, there's a range of brands from 20 or
so milligrams of tar down to virtually
nonmeasurable levels of tar. So I don't know how
to put Premiere in context of the market other than
to say that it's at the ultra-low end of it.
I don't recall specifically what the tar
level was.
Q: What cigarettes does RJR have that have
practically immeasurable tar content?

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A: Our Now product.
Q: The Now?
A: Yes.
Q: And what would it be on nicotine?
A: I believe the FTC values for Now are approximately .5 milligrams of tar and .05 milligrams of nicotine.
Q: If it's .05 of nicotine, that's considerably under the Eclipse then, would it not?
A: That is - I believe Eclipse has a .3 FTC measured nicotine, so .05 is substantially lower.
Q: How long has Now been on the market?
A: I don't know.
Q: Well, what was the essential difference between the Premiere and Eclipse?
A: The essential difference?
Q: Well, what was the difference?
A: There are a number of differences in the design and configuration. Premiere was a tobacco-heating cigarette. Eclipse is primarily tobacco-heating. But there are a number of design and configuration, formulation changes. I don't know that I can specifically point to essentially one difference.
Q: Well, were each contained in the water and

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glycerin increase in the Premiere as you indicated maybe? Did you say that there was an increase in the water and glycerin content in the Premiere?
A: Relative to traditional cigarettes, water and glycerin yields in the cigarette smoke from Premiere was substantially higher than traditional cigarettes.
Q: I have a copy of the Eclipse here showing that 80 percent water and glycerin in the Eclipse, whereas it's sort of the reverse of that in the average cigarette.
MR. LEE: Let that be Exhibit 3.
MS. FORBES: Mr. Lee, what's the source of this?
MR. LEE: The source of that -
BY MR. LEE:
Q: Do you recognize the source of that, Dr. Gentry?
A: I don't know for certain. It looks like it may be a packing insert.
Q: It is. This is the other side of it.
Let one be 3 and the other 4.
A: And what is the question?
Q: And the question is: It appears that the water and glycerin content of Eclipse is 80

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percent, whereas in the average cigarette or other cigarettes, it's identified there - it looks like it's 20 percent?
A: By the FTC measurement that those are made on, yes.
Q: Uh-huh. It's what that pamphlet says?
A: Yes.
Q: Well, was that the way the Premiere was?
A: To my best recollection, there was a substantially larger percentage of water and glycerin in the smoke of Premiere than in traditional cigarettes. I don't know if the numbers are specifically the same.
MR. LEE: I'll tell you, it's about five minutes to twelve. Let's break for lunch.
MS. FORBES: Good stopping place. Okay. What do you want to say, back on the record at one?
MR. LEE: Yeah, we should be able to do that.
(RECESS TAKEN FROM 11:55 A.M. TO 1:00 P.M.)
(EXHIBIT NUMBERS 2, 3 AND 4 WERE MARKED FOR IDENTIFICATION)
MS. FORBES: For the record, in the morning session of the deposition, Mr. Lee

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indicated that there's additional document production occurring in Arch and you've requested to reserve the right to come back and examine Dr. Gentry in light of that document production.
I spoke with counsel involved in Arch litigation over lunch. It's my understanding that only certain documents relating to ingredients and certain other documents that have been designated in the Minnesota production as highly confidential are being produced as a voluntary production.
At this point, it is not anticipated that those would relate in any way to Dr. Jeff Gentry. So, I understand that you are reserving the right. And just so the record is clear, we are not agreeing to that additional production of Dr. Gentry at this point understanding what that document production is. Thank you.
BY MR. LEE:
Q: Dr. Gentry, we have several patents furnished us, and I'll put them in just one at a time. And for keeping up with them, I'll write in the upper right-hand corner the number, and then when we finish, the court reporter can tab them.

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Exhibit 5 is a Patent 5,415,186 under date of May 16, 1995. And I'll make it Exhibit 5.

(EXHIBIT NUMBER 5 WAS MARKED FOR IDENTIFICATION)

Are the co-inventors with you on this patent all co-employees at RJR?

A: With the exception of one, they are all current employees.

Q: And which one is that? Is it a former employee then?

A: Yes. Kelly Hutchinson is no longer with R.J. Reynolds.

Q: Has she retired, or he retired, or just relocated?

A: Kelly - I don't know whether she took early - voluntary retirement or separation. I'm not sure exactly what the conditions of her leaving were.

Q: Where is she now located?

A: She's still in Kernersville.

Q: Just name off the others there and tell me who they are and what is their title or employment, if you know.

A: I can read them off and give you what I believe their title may be.

Q: If you would.

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A: I'm not a hundred percent sure. William J. Casey is a senior scientist or senior staff scientist. Then myself. Alvaro Gonzalez-Parra is a senior staff scientist. Aju Lekwauwa is - I don't know what his specific title may be. Dennis Rigg is a master scientist. Gary Shelar is a master scientist. Kenneth Swicegood is a master scientist. Ron Wagoner, I don't know his title. Jeff Willis is - I don't know his title. Sorry. Doug Young, I don't know his title. And Kelly Hutchinson has retired or left the company.

Q: Now, what was the purpose of this patent? What is it designed to do?

A: I have to refamiliarize myself exactly, but this was work that was done to develop substrate materials for potential use in products such as Eclipse.

Q: And why was this product needed? Why did you wish to do this product?

A: "This product" being Eclipse or the substrate?

Q: No, the substrate of the product Eclipse.

A: The smoke formation mechanism for Eclipse was to contain a significant amount of aerosol, and there had to be a vehicle from which a thermally

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generated aerosol could be produced. And that's what we use when we talk about substrates. Substrates are vehicles for which a thermally produced aerosol can come from.

Q: And then, in a nutshell, what's the difference in the Eclipse and the average or conventional cigarette?

A: In a nutshell?

Q: Well, yeah, or however you'd put it.

A: One of the main striking differences between Eclipse and traditional cigarettes is Eclipse is a - primarily heats rather than burns tobacco and traditional cigarettes burn tobacco.

Q: And was that not also the way that the Premiere was?

A: Premiere, I believe, was said to be heating - heating tobacco, where Eclipse is primarily heating tobacco.

Q: So each of them were heating tobacco as opposed to burning?

A: That was the majority of the function.

Q: Is it fair to say that RJR was attempting to do a safer cigarette?

A: I don't know that I would say we were attempting to do a safer cigarette. We were

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certainly proactively addressing allegations in the whole smoking and health realm, trying to simplify smoke chemistry, reduce constituents, and, in fact, in cases like Premiere and Eclipse, substantially change the product.

Q: And do you have an opinion, professional or personal, as to whether or not that in turn would make a safer cigarette to address the health issue?

A: I'm certainly not an expert, and even personally speaking, I don't know that it makes a safer cigarette. It certainly, in my opinion, may address the risk that's associated with cigarette smoking.

Q: That is, reduce the risk?

A: Eclipse or Premiere in which the chemistry of the smoke is substantially changed may reduce the risk associated with smoking.

Q: And have you an opinion as to whether that may or very probably may reduce the risk?

MS. FORBES: Object to the form.

THE WITNESS: I don't know. May is the best I can say.

BY MR. LEE:

Q: Now, the Surgeon General in publications has indicated that there is no such thing as a safe

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cigarette or a safe level of consumption of a cigarette. Have you ever heard that reference?
A: Specifically tied to the Surgeon General, I don't know. I've heard that - I certainly heard through the media or other places that there is no safe cigarette.
Q: Do you have an opinion yourself as to whether that holds true or not, Dr. Gentry?
A: I'm sorry. What holds true?
Q: That there is no such thing as a safe cigarette.
A: I don't know what "safe cigarette" means. There's risk associated with smoking. And I don't know exactly what safe cigarette means.
Q: What are those risks associated with smoking?
A: Smoking has been associated with a number of diseases - lung cancer, heart disease, although I'm not even familiar enough to say what kinds of heart disease, emphysema. And there's probably others, but I can't recall right now.
Q: Cardiovascular, peripheral vascular disease Berger disease?
A: Yes. Well, cardiovascular disease, I put that in my definition of heart diseases.
Q: Would that include peripheral vascular

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disease?
A: I don't know.
Q: You mentioned earlier bladder cancer, I remember.
A: Bladder cancer was associated with two compounds that we were looking to reduce in the - in cigarette smoke. Bladder cancer, to my knowledge, is not - the risk for bladder cancer is not associated with cigarette smoking, to my knowledge.
Q: Now, in Exhibit 5, the patent under date of May 16, 1995, on page 4, or column 4, talks about ammonium alginate. And it appears to talk about how that you can vary ammonium alginate between 6 to 15 percent weight of ammonium alginate such as that is available from the Kelco Division of Merck & Company. It's that paragraph right in there.
(DOCUMENT HANDED TO WITNESS FOR REVIEW)
How does that work, Dr. Gentry? What's the basis of that?
A: Okay. I'm sorry. What do you mean, "how does that work"?
Q: That is, is it possible to do various percentages of ammonium alginate?
MS. FORBES: Objection to the form.

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THE WITNESS: In the context of what we were looking at in this particular patent, dealing with this substrate development, the ammonium alginate is a binder, much like carboxymethylcellulose. It's a type of binder that is used to stick particles together. And it's a way to make sheet-type material.
And you can vary the level of that binder depending on the amount of strength that the sheet needs to have for production.
BY MR. LEE:
Q: How do you vary it?
A: Simply by varying the composition of the particular sheet.
Q: Is that part of the reconstituted tobacco concept?
A: This is not a material that we use in commercially available tobacco-burning cigarettes.
Q: Is it used in the conventional or average cigarette?
MS. FORBES: Objection to the form.
THE WITNESS: I don't know what you mean by "conventional or average."
BY MR. LEE:
Q: Well, one other than an Eclipse or Premiere.

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A: At this point in time, since I haven't been directly involved with Eclipse, I'm not even sure a formulation such as that exists in Eclipse today. And to my knowledge, no cast sheet, such as that is, is used in - in RJR products in the marketplace.
Q: How does the - your co-inventors and all of you work together? Is it sort of like a committee or each contributes certain parts of it? Or how do you go about coming up with the ultimate patent?
MS. FORBES: Objection to the form.
THE WITNESS: Could you restate or break that -
BY MR. LEE:
Q: Yeah. There's several of you on the inventors list.
A: Yes, sir.
Q: And how does that come about? I mean, do each of you contribute certain portions to it, or you do it in a committee-like atmosphere, or just how does that come about?
MS. FORBES: Objection to the form. You may answer.
THE WITNESS: We, like many companies, operate in team formats nowadays. And,

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in fact, the members there are across a variety of divisions within the research and development department. Individual aspects of the whole concept behind that patent were intellectual properties of those particular individuals.

BY MR. LEE:

Q: Somewhere I've got a list of Project Alpha, sort of a diagram of some sort. Let me pass it to you and see if some of those on the list are part of it.

Before I hand it to you, would all of these people that you named off on Exhibit 5, would they be involved in Project Alpha?

A: Were they involved in Project Alpha?

Q: Yes. Yes. Were they?

A: I'd have to review the list again.

(DOCUMENT HANDED TO WITNESS FOR REVIEW)

I don't know the full list of people on Project Alpha at the time it was an active project. I believe - I believe everyone here in some form or another worked with Project Alpha. I'm not a hundred percent sure of that, but I believe they did.

BY MR. LEE:

Q: Let me pass you this and mark it as

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Exhibit 6. This just has the heading, "Project Alpha Organizational Structure."

Have you seen that chart before? Are you familiar with that chart?

A: I may have seen it. I certainly don't recall seeing this specifically. This was a long time ago.

Q: Okay. So as you thumb through it, do you recognize the names of individuals that worked on Project Alpha?

A: As I thumbed through that document, I recognized several names.

Q: That you recall were involved with Project Alpha?

A: To the best of my recollection, I did recognize several names that were involved in Alpha.

Q: Okay. I'll offer that as Exhibit 6 - and this one we'll mark as Exhibit 7. And it appears to be a similar but a little bit different list.

(EXHIBIT NUMBER 6 AND 7 WERE MARKED FOR IDENTIFICATION)

(DOCUMENT HANDED TO WITNESS FOR REVIEW)

Do you recognize that as a similar list but a little different, that's associated with

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Project Alpha?

A: In comparing - I haven't directly compared the two documents. There does appear to be names that are on both documents. I didn't specifically look for particular differences between the two.

Q: Flip to the last page, and it looks like - how is it -

A: "Law Project Alpha."

Q: And Law Project Alpha, that deals with the patents involved. Do you recognize those names?

A: Yes, I do.

Q: And was the patent that we were just talking about - now, it wasn't involved with Project Alpha, the patent that we talked about earlier, Exhibit 5, because that was after Project Alpha was over?

A: That's after Premiere was withdrawn from the test market, yes. I am sorry. I don't know if you had a question.

Q: All right. The question to you that I put now, if I didn't ask this morning, was: Why was Project Alpha discontinued?

A: Premiere, which was the product resulting from what we termed as Project Alpha, was test marketed, consumers did not accept the product at

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all, and, to the best of my knowledge, we withdrew it from market for reasons that the consumer did not accept the product.

Q: Do you know why they didn't accept it?

A: From what I read in the newspaper, certainly they didn't like the taste or the smell.

Q: Was it ever touted, advertised, or promoted by RJR as a safer cigarette?

MS. FORBES: Objection to the form.

THE WITNESS: I don't know if I - I don't know how to answer that question. Was it - I'm sorry?

BY MR. LEE:

Q: Was it ever promoted by RJR as a safer cigarette?

A: Certainly not to my knowledge. I don't know what safer cigarette would be. Not to my knowledge.

Q: Do you have any feelings yourself of whether or not it was a safer cigarette?

A: As I testified earlier, there was a substantial change in the chemistry and the nature of the smoke. There was a number of constituents that were associated with the risk of smoking that were significantly reduced.

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As to causation or associated with being safe, I'm not an expert and can't really offer an opinion on that.
Q: I hand you the next patent, and you appear to be the only inventor on it.
(EXHIBIT NUMBER 8 WAS MARKED FOR IDENTIFICATION)
A: Yes, sir.
Q: What was the purpose of that invention?
A: The purpose of this invention was to provide a cigarette paper system which significantly reduced sidestream smoke, sidestream tar.
Q: And why did you consider that necessary?
A: Why did we consider -
Q: Reducing sidestream smoke as necessary.
A: Reducing -
MS. FORBES: Objection to the form.
THE WITNESS: Reducing sidestream smoke was something that consumers were asking for. We had done research, marketing research. I had not specifically, but our company had. And reduction in sidestream smoke was an area that was judged important.
BY MR. LEE:
Q: And why was it important?
A: Why was -

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Q: Reduction of sidestream smoke important?
A: To the consumer.
Q: Yes.
A: I can only speculate what those reasons may be. But probably, annoyance to those around them, just the social pressures that smokers were put under.
Q: Well, did that not get into ETS, environmental tobacco smoke, or secondhand smoke issue?
A: No.
MS. FORBES: Objection to the form.
THE WITNESS: Could you restate it.
BY MR. LEE:
Q: Did that not address the ETS, environmental tobacco smoke, or the secondhand smoke issue as it affected the health of people that did not smoke?
MS. FORBES: Again, objection to the form.
THE WITNESS: I'm sorry. That has too many elements. If you could break it down.
BY MR. LEE:
Q: Okay. Did that reduction of sidestream smoke, did that not address the health issues of the secondhand smoke, secondhand smoke being smoke

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by the nonsmoker the is alleged to kill people?
MS. FORBES: Objection to the form.
THE WITNESS: We developed that particular paper system referred to in that patent to address consumer desires for reduced sidestream smoke - not secondhand smoke, but sidestream tar - that is, the tar that's produced or the smoke that's produced from the lit end of the cigarette.
There was no intent for that to address, in my opinion, ETS, or secondhand or environmental tobacco smoke.
BY MR. LEE:
Q: Okay. Did it do that then? It was effective in reducing sidestream smoke?
A: The paper system and the product configurations described in that patent are very effective in reducing lit-end smoke or sidestream tar.
Q: It was not an attempt in any way to reduce the nicotine, was it?
A: I'm sorry?
Q: It had no intent of reducing the nicotine?
A: I'm not sure I fully understand. The patent we're talking about?

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Q: Uh-huh. Yeah.
A: The cigarette paper designs spoken to in that patent were not developed to address nicotine at all. That was not the objective of that research. It was simply to provide a reduction in sidestream tar as wanted by consumers.
Q: Did you consider sidestream tar as being harmful or a risk to the smoker in any way?
A: Did I consider sidestream tar?
Q: Yeah.
A: Once again, I'm not an expert in medical or toxicology. But I did not, in the context of that patent, contemplate that.
Q: The next one, I'm marking it as Exhibit 9 in the lower right-hand corner and just ask you - let me look at the date - under date of March 14, 1995, and ask you the purpose of that patent.
(EXHIBIT NUMBER 9 WAS MARKED FOR IDENTIFICATION)
(DOCUMENT HANDED TO WITNESS FOR REVIEW)
A: It's been a while since I've looked at this, but I believe this also was a development of a substrate material for thermally generating aerosols in Eclipse-type products. It must have some slight difference from Exhibit 5.
Q: Here's 5. And why did you need to do that?

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A: I'm not a patent attorney and, to be honest, I don't know. There may be slight differences between the patents. Without going through them thoroughly, I don't know.
Q: What was the purpose of reducing the aerosol? Why did you need to do that?
MS. FORBES: Objection to the form.
THE WITNESS: As I stated, this was the development of substrate materials for cigarettes such as Eclipse which relied on the thermal production of aerosol.
I'm not sure I fully understand your question.
BY MR. LEE:
Q: Well, why did you want to reduce the aerosol in the Eclipse as opposed to the average or conventional cigarette?
MS. FORBES: Objection to the form.
THE WITNESS: We weren't trying to reduce the aerosol. That was a substrate for producing aerosol, particularly a glycerin aerosol that was thermally generated and produces the smoke-like appearance. And you do that because that was a product that heated tobacco rather than burning tobacco.

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BY MR. LEE:
Q: All right. Now, the co-inventors on here with you, William Casey - there seems to be some of the names that's on the others. Were they also involved in the - well, what would that team be that's on there with you?
A: Once again, we do a number of things in teams. In this particular case, I'm not even sure this was a team. This was - we were working in different functions at this particular time. We just all had different levels of the intellectual property that went into this patent, or these two patents.
Q: Okay.
(EXHIBIT NUMBER 10 WAS MARKED FOR IDENTIFICATION)
Let me hand you Exhibit 10. I've just marked it Exhibit 10. And ask you: What is that patent - and what's the date of that one?
A: October 29th, 1996.
Q: And what is that patent?
A: This is a patent on an exploratory-type cigarette filter that we were investigating for use on traditional tobacco-burning cigarettes.
Q: What's the purpose of the filter?
A: The purpose of this filter was to reduce a

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number of constituents in mainstream cigarette smoke.
Q: And what would those constituents be?
A: Many would be vapor-phase or gas-phase compounds. There's a lot of them. Some of the major ones that come to mind would be the carbonyl compounds, acetaldehyde, formaldehyde, acrolein acetone, carbon monoxide, nitric oxides or oxides of nitrogen, a number of gas-phase and vapor-phase compounds.
Q: Why is it important to reduce those?
A: A number of those compounds have been associated with - or found in cigarette smoke and have been associated with the risk of smoking.
Q: Causing disease and death from smoking?
A: No, sir, I didn't say that.
Q: Okay. All right. Does it do that?
A: I can't give you an opinion on that. I don't know what causes that association between cigarette smoking and diseases.
Q: But those are the constituents or compounds, or whatever you'd put them, that's been in cigarettes, and that risk associated with it is what's been recognized for 40 or 50 years that we talked about earlier this morning, was it not?

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MS. FORBES: Objection to the form.
THE WITNESS: I'm not sure I understood all parts of that question.
MR. LEE: Okay. Help me, Beth, and read that back and see how it sounds.
(PREVIOUS QUESTION READ BY REPORTER)
THE WITNESS: I would like to ask if you could break that into a number of questions.
BY MR. LEE:
Q: All right. You named off several constituents of smoke that have been associated with smoking and disease, or smoke - those constituents causing disease, did you not? I mean, I think you recognized that as -
MS. FORBES: Objection to the form. I think that mischaracterizes his testimony.
THE WITNESS: Yes, it does. I testified that many of those constituents were identified in cigarette smoke. They have been identified by various organizations as being possibly associated with the risk of smoking and diseases.
We took those allegations very seriously, whether we knew them to be true or not. Many of those constituents, in this case, they're

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in the vapor or gas phase. This morning we talked a lot about the tar and particulate phase. These happen to be in the gas or vapor phase.

BY MR. LEE:

Q: And those have been recognized as being a health risk for some 40 or 50 years?

MS. FORBES: Objection to the form.

I think that's not what he's testifying to.

MR. LEE: Yeah. Okay.

THE WITNESS: I hope I have said that many of those constituents have been found - in fact, all of those constituents have been found in cigarette smoke. They have been identified by various organizations - IARC, Surgeon General, the World Health Organization - as compounds which are present in cigarette smoke that have an association with disease, not necessarily in cigarette smoke.

As I testified earlier this morning, after 40 or 50 years of research, no one knows what constituents of cigarette smoke are necessarily associated with that risk.

BY MR. LEE:

Q: No one knows that you can name off, or are you just saying that that is a fact that no one

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knows that?

MS. FORBES: Objection to the form.

THE WITNESS: To my knowledge, no one knows what constituents in cigarette smoke are connected with the association between cigarette smoking and disease.

BY MR. LEE:

Q: Did you ever hear of C.E. Teague with R.J. Reynolds?

A: I've heard the name, yes.

Q: I've seen a memo from C.E. Teague under date of February 2, 1953, wherein he states: (Reading)

Studies of clinical data tend to confirm the relationship between heavy and prolonged smoking and incident of cancer of the lung.

Now, that would fall within what we're talking about of this risk associated with those constituents, would it not?

MS. FORBES: Objection to the form.

And, Mr. Lee, do you have a copy of the document? I'll point out that Dr. Gentry was not even born at that point, and I know you're - if you've got a

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document, we'd be glad to review it.

MR. LEE: I will try and find it.

BY MR. LEE:

Q: And there's also another one by Allen Rodgman that you indicated that - that you'd heard of him. You didn't know him - or did you know him?

A: That's correct. I have heard of him but have never met him.

Q: Which, I've got in my notes it says that: Obviously, the amount of evidence accumulated to indict cigarette smoke as a health hazard is overwhelming.

And that was - I don't have the date of that.

MS. FORBES: Again, the same objection. I mean, if you're reading from a document, we'd like a chance to review it and find out what the question about the document is since Dr. Gentry was not living, I guess, in the 1950s.

BY MR. LEE:

Q: Now, again, this would be - if I can find either one of those, I'll show them to you. It's just in my notes that I've written from it.

I don't have the document. I've just got in my working papers of where I refer to, in

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RJR 101, page 1265, the document that I've taken that from.

MS. FORBES: Again, if you have a document you'd like to have us review and a question about it, we'd be glad to address it. But I assume you don't want to produce your working papers.

MR. LEE: Well, it wouldn't make sense that much. It's just a whole bunch of things with references on it.

BY MR. LEE:

Q: Would you agree or disagree with the statement that I read from the C.E. Teague, dated February 2, 1953? (Reading)

Studies of clinical data tend to confirm the relationship between heavy and prolonged smoking and incident of lung cancer.

A: Without seeing the document and the context in which that was written, I really don't know if I have any opinion about that.

Q: Well, I thought that this was from - but I don't find that language in it.

I do find it after all, on page 7 of

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this document. This is a document that's indicated as the author being Allen Rodgman, Division of Chemical Research, and under date of 1962. And what I was quoting is over on page 7, Evidence to Date. Quote: (Reading)

Obviously, amount of evidence accumulated to indict cigarette smoke as a health hazard is overwhelming. And the evidence challenging such indictment is scant.

Have you ever seen or heard those languages such as that shown in that document?

(DOCUMENT HANDED TO WITNESS FOR REVIEW)

A: I've never seen this document. It's quite lengthy, and I haven't reviewed it.

What's the question?

Q: The question is: Have you ever seen or heard of such a statement as that embraced in that document by Allen Rodgman?

A: I've never seen or heard this specific statement. I've never seen this document. But I've heard similar sort of things.

Q: And where have you heard similar or sort of

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things?

A: Read similar sort of things, I meant to say.

Q: Do you know whether or not that your retrieval system, either on computer or at your disposal, could call up documents such as that?

A: I don't know.

Q: Let me continue going through - Number 10 was the last one we marked, on October of '96.

(EXHIBIT NUMBER 11 WAS MARKED FOR IDENTIFICATION)

Let me hand you Number 11, which is dated April 11, 1995, and again on a cigarette filter.

Can you tell offhand the difference in it and the one earlier?

MS. FORBES: You mean Number 10?

MR. LEE: Yeah, Number 10, uh-huh.

THE WITNESS: The difference between Exhibit 10 and Exhibit 11?

BY MR. LEE:

Q: Yes. Each of them addresses filters, it looks like.

A: Yes, sir. Both address filters which are associated with exploratory development of products in which the gas or vapor phase of cigarette smoke was intended to be reduced. There appears to be

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just a difference in the - a difference in the drawings on the second page of both patents. Without reviewing them in detail, I don't know what the specific differences are.

Q: And again, the same purpose was to reduce the sidestream smoke, was it?

A: No.

MS. FORBES: Objection to the form.

THE WITNESS: The specific reason for both of these patents was to provide a cigarette filter which reduced a number of constituents in mainstream cigarette smoke.

BY MR. LEE:

Q: And why did you want to do that?

A: As I testified earlier with Exhibit 10, that a number of the constituents that we have confirmed are in cigarettes, that people have associated - when I say people, I mean the Surgeon General or the World Health Organization or IARC - have associated with the risk of smoking or the risk of disease, we took those allegations very seriously and sought to reduce those constituents.

Q: Were you able to do that?

A: Were we able to -

Q: Reduce -

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A: - reduce those constituents?

MS. FORBES: You mean pursuant to Patent Number 11, Exhibit Number 11?

MR. LEE: Yes.

THE WITNESS: Yes. In laboratory and within the R & D setting, we significantly reduced a number of those constituents.

BY MR. LEE:

Q: And did that start commercially being manufactured or - when in pursuant to that patent?

MS. FORBES: Objection to the form.

THE WITNESS: Neither one of these filters are in commercial use. They have failed to find either commercial feasibility or consumer acceptance. They were technically feasible in the laboratory and within the walls of research and development, but have not reached commercial feasibility or consumer acceptance levels.

BY MR. LEE:

Q: Do you have any anticipation of that ever reaching the consumer?

A: With respect to these two patents?

Q: Yes.

A: Filters of these configurations. We have consumer tested and pursued development of these

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types of filters, consumer tested them, and they have not scored very well with respect to the acceptance of the consumer in the taste of the cigarette.

Q: So you don't anticipate that they will be commercially produced then?

A: We continue to work on them, but I can only speculate where we will get to.

Q: So those constituents that - of the cigarette smoke that you wanted to take out, that you indicated has been associated with disease caused by cigarette smoke, still remains in the cigarette smoke, then, do they not?

MS. FORBES: Objection to the form.

THE WITNESS: I believe my testimony may be a little mischaracterized or maybe I'm not conveying it very well.

Many constituents that have been associated with the risk of various diseases or identified by the Surgeon General, IARC, World Health Organization, as being associated with a particular disease in the absence of cigarette smoke, just those constituents have been associated with particular disease endpoints.

We have identified the presence of

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those constituents in cigarette smoke and simply sought to reduce them in our work.

BY MR. LEE:

Q: But you've not been able to do that and put it out in a commercially produced cigarette, have you?

MS. FORBES: Objection to the form.

THE WITNESS: Have we been able to -

MR. LEE: Uh-huh.

THE WITNESS: - reduce chemical constituents?

BY MR. LEE:

Q: Yeah, you've been able to do that, but it's not been done in a commercial form, has it?

MS. FORBES: Objection to the form.

THE WITNESS: In the execution of these two patents, in other words, the cigarette filters described in these two patents, no. With respect to significant reductions in tar, gas phase of cigarette smoke over 40 to 50 years, yes, that has been accomplished in major fashion.

BY MR. LEE:

Q: And how has that been accomplished?

A: By a number of cigarette design techniques.

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We have affected the reduction of tar, we have affected the reduction of gas phase by design techniques.

Q: When you say that we have identified those, how did you identify those constituents that were identified as being a health risk, or however you put it?

MS. FORBES: Objection to the form.

THE WITNESS: The Surgeon General, the International Agency for Research on Cancer, and the World Health Organization have identified a number of compounds, not exclusive or not inclusive - not exclusive of cigarette smoke. We did not identify those associations.

BY MR. LEE:

Q: Okay. When you said "we," you meant just generally across the board of different people. Different organizations have identified it. You didn't mean that you had.

A: I assume that's what I -

MS. FORBES: I think we're getting all a little tangled up here.

Maybe if you can just start with a clean question, and Jeff will give a clean question.

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BY MR. LEE:

Q: When you said "we identified," you didn't mean RJR identified?

A: Of the 4,000 or more constituents in cigarette smoke, R.J. Reynolds has identified a vast majority of those constituents.

Q: And that's consistent with the International Agency on Research in Cancer, is it not?

A: I don't know what you mean by is that consistent.

Q: Well, RJR has identified within those 4,000 constituents that have been associated with risk of disease caused by those constituents in cigarette smoke.

MS. FORBES: Objection to the form. I think we're getting tangled up in the use of your word "identified." And maybe if you could ask a new question, Dr. Gentry can get at it in a better way.

BY MR. LEE:

Q: Well, benzo(a)pyrene is one of those, isn't it?

A: Benzo(a)pyrene is present in cigarette smoke.

Q: Right. And that's one of the constituents that you'd like to reduce that you're talking

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about?
A: Benzo(a)pyrene in smoke outside cigarette smoke has been identified as a carcinogen.
Q: And you recognize that yourself, do you not?
MS. FORBES: Objection to the form.
THE WITNESS: I'm not sure I know what you mean by "recognize."
BY MR. LEE:
Q: You recognize and accept that benzo(a)pyrene is a carcinogenic agent that causes disease in human beings.
A: I'm not an expert that can testify to that. I don't know that. I know that it's been identified by the Surgeon General, the International Agency for Research on Cancer, the World Health Organization, as a carcinogen.
R.J. Reynolds has identified benzo(a)pyrene in cigarette smoke. And simply, we have taken the allegation that someone has said, whether we believe it or not, or know it to be true, that benzo(a)pyrene is a carcinogen.
Therefore, taking that allegation seriously, we sought to reduce benzo(a)pyrene, the

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same analogy for these various constituents we've been talking about.
BY MR. LEE:
Q: But you've not been able to reduce that, have you?
A: Benzo(a)pyrene?
Q: Uh-huh.
MS. FORBES: Objection to the form.
THE WITNESS: Over what period of time?
BY MR. LEE:
Q: Any period of time. Is it still in cigarette smoke?
A: Benzo(a)pyrene is still a constituent of cigarette smoke, albeit at very, very low levels.
Q: And when you say a low level, what do you mean a low level? Is there such a thing as a safe level of benzo(a)pyrene?
MS. FORBES: Objection to the form.
THE WITNESS: I don't know what specifically is meant by "safe." I'm not an expert in that area. I don't know the area of carcinogens.
(EXHIBIT NUMBER 12 WAS MARKED FOR IDENTIFICATION)

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BY MR. LEE:
Q: I hand you Exhibit 12, which is under the date of November 1, 1994, and it also is a cigarette filter. What is the purpose of that patent?
A: Once again, in the context of this patent, this was an exploratory filter that we were investigating to reduce the gas and vapor phase - many of the gas and vapor phase constituents of cigarette smoke.
Q: So that's similar to what we were talking about in Exhibits 10 and 11, would it not?
A: It's a different filter configuration from 10 and 11.
Q: How is it a little different?
A: This particular filter had a different type of carbon filter element.
Q: And what was the purpose of that carbon filter element?
A: The carbon filter element - has been known for a number of years - carbon filter are selective in the reduction of many vapor-phase, condensable vapor-phase materials. And we developed a very efficient carbon filter. That's what's spoken to in the patent.

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Q: Is it in commercial use, then?
A: A variant of this cigarette filter - without reviewing the entire patent, I don't know if the specific filter, but a variant of this filter, at least, is used presently in the test market.
Q: Do you have an opinion yourself within your work and profession, Dr. Gentry, as to whether or not a filtered or unfiltered cigarette has any difference on the health risk involved?
A: I'm sorry. Could you restate that.
Q: RJR currently sells and promotes both filtered and unfiltered cigarettes, do they not?
A: Yes, we sell both filtered and nonfiltered cigarettes.
Q: For instance, I know I think of Camel as an unfiltered cigarette. Is there a filtered Camel?
A: Yes, sir, there is.
Q: Okay. So there's both filtered and unfiltered Camels?
A: Yes.
Q: Now, what's the difference in those two from a health risk standpoint, if there's any difference?
A: I don't know how to assess any difference in health risk between the two cigarettes. I'm not an

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expert in that area. I don't know how you would begin to assess that.

Q: Okay.

MR. LEE: Let's take a short break here.

MS. FORBES: Sure.

(RECESS TAKEN FROM 2:00 P.M. TO 2:12 P.M.)

(EXHIBIT NUMBER 13 WAS MARKED FOR IDENTIFICATION)

BY MR. LEE:

Q: Let me hand you the next one, which is marked as Exhibit 13, and that's a patent under date of April 21, 1992, cigarette and smokable filler material. What is that patent?

A: This was not a filter. This was a cigarette and smokable filler. And this was exploratory research in the development of material other than tobacco which can be included in cigarette for reduction of cigarette tobacco inclusion levels.

Q: And what was the purpose of it?

A: In general, the purpose of the development of this alternate smokable filler was to be able to reduce the pyrolysis of tobacco and constituents in smoke.

Q: When it talks about the CORESTA, C-O-R-E-S-T-A, units, what is that?

A: CORESTA.

Q: CORESTA.

A: That is a measurement of the porosity of cigarette paper.

Q: Is that some kind of a standard that's recognized within the industry?

A: I believe the CORESTA unit measurement is recognized within the domestic industry. I'm not an expert in test methods, but I believe that to be the case, for measurement of paper porosity.

(EXHIBIT NUMBER 14 WAS MARKED FOR IDENTIFICATION)

Q: Okay. The next one I've marked, Exhibit 14 under date of December 21, 1993, is a patent for cigarette. Tell us about that patent.

(DOCUMENT HANDED TO WITNESS FOR REVIEW)

A: This particular patent spoke to the development of a cigarette which was intended to reduce the level of sidestream tar, sidestream smoke, and also contained a filter similar to the one we previously described in Exhibit 12.

Q: Did it accomplish then reducing the sidestream smoke?

A: Yes. A cigarette configured such as some of the samples contained within this patent reduced the level of sidestream tar compared to a cigarette

without those papers.

(EXHIBIT NUMBER 15 WAS MARKED FOR IDENTIFICATION)

Q: And then this one, marked 15, under the date of December 24, 1991, is also on a cigarette. Tell us about it.

(DOCUMENT HANDED TO WITNESS FOR REVIEW)

A: This one is a little harder to remember. It's a little older. But in glancing at it, it appears to be one in which we were developing an alternative filler for the tobacco column which could be used in combination with tobacco to reduce the weight of tobacco to make the cigarette.

Q: Okay. Did either one of those, either Exhibit 14 or 15, involve the Eclipse?

A: No. These were traditional tobacco-burning cigarettes.

Q: Okay. Do you know who holds the patent on the Eclipse?

A: No, I don't, not off the top of my head.

Q: Tell me about Donna Woods. Do you work with Donna Woods?

A: I do not currently work with Donna Woods.

Q: Do you know her? Is that a man or woman?

A: Donna is a woman in the research and development department.

Q: Does she hold a Ph.D.?

A: Not to my knowledge.

Q: What does she do?

A: I'm not entirely sure. She works in our brands R & D group. I'm not entirely sure of what her job is currently.

Q: But you have worked with her some?

A: Yes. At one time we were in the same group.

Q: In the Premiere?

A: No. It was subsequent to Premiere, subsequent to -

Q: That is, after Premiere was abandoned?

A: Yes. Donna and I worked briefly in the same group.

Q: And what did you work on? What did you do with her?

A: In that particular period of time, we were working on materials such as that described in Patent Number 15 - I'm sorry - Exhibit Number 15.

Q: Exhibit 15, yeah. And that is on a new conventional cigarette?

A: It's on a traditional tobacco-burning-type cigarette, but it was exploratory development of prototypes.

Q: Well, did Exhibit 15, did it, in fact, reduce

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the sidestream smoke in the conventional cigarette?
A: Exhibit 15?
Q: Yeah. I'll hand it back to you.
A: I am having a hard time remembering any specific measurements or levels of reduction, but it does say in the abstract that: Generates low levels of visible sidestream smoke.
Q: Why was that important? Why did you want to do that?
A: Once - why did we want to reduce the level of sidestream smoke?
Q: Yes.
A: Once again, it was to speak to what our marketing research had identified as a consumer want, and that was reduction of sidestream smoke.
Q: Because of alleged health hazards?
A: I don't know that to be the case at all.
Q: Why would they -
A: Maybe annoyance.
Q: Annoyance. How long a period of time did you work with Donna Woods?
A: This has been a long time ago. Six months to a year maybe.
Q: Do you know Dr. J.D. Woods?
A: I have heard - excuse me. Can you tell me

what J.D. stands for?
Q: I don't know. All I know is just those initials. And it may not be J.D. Let me look and see. It's - Dr. J.D. Woods reference is all I have.
MS. FORBES: For the record, I notice you're getting the name from the document. What's the year? That may help.
MR. LEE: First draft, November 12, 1968, and second draft, February 6, 1969, signed by Claude E. Teague, Jr.
MS. FORBES: Does that help you put -
THE WITNESS: I have heard of a John Woods. I don't know if it was J.D. or doctor. I've heard of a John Woods. I believe it was John.
BY MR. LEE:
Q: That could be the same person. Let me hand you the document that I'm referring to and see if you recognize it as ever having seen it or know anything about it. That was the C.E. Teague I mentioned earlier.
A: No, I've never seen this document.
Q: Have you ever heard of glass fiber having been caused or side effect of the Premiere

cigarette?
MS. FORBES: Objection to the form.
THE WITNESS: I'm sorry. Could you restate.
BY MR. LEE:
Q: Yeah. Anything in the Premiere cigarette that's not in the conventional cigarette smoke or average cigarette smoke or the run-of-the-mill cigarette smoke?
MS. FORBES: Objection to the form.
THE WITNESS: I'm still not sure I understand the question.
BY MR. LEE:
Q: Okay. The question is: Have you ever heard of glass fiber being a product of the Premiere cigarette that is not in the conventional cigarette?
A: A product of the Premiere cigarette?
Q: Yeah.
A: Glass fiber was a component, or it made up a component, that was used in Premiere cigarettes.
Q: Okay. And that's not in the conventional cigarette, was it?
A: That's correct. Glass fibers are not used in

the manufacture of traditional tobacco-burning cigarettes.
Q: And was that desirable? Did the consumer like the glass fiber that ended up in the Premiere smoke?
A: I don't know that -
MS. FORBES: Objection to the form.
THE WITNESS: I don't know that glass fiber ended up in the smoke of Premiere cigarettes. And I don't know what the consumers' response to that was.
BY MR. LEE:
Q: Okay. So the glass fiber was just in the Premiere cigarette?
A: It made up a component, an insulator around the fuel element.
Q: Have you ever heard of cigarette smoke causing enlargement of the heart or causing the heart to become large?
A: No, I have not.
MR. LEE: Let's talk just a minute. And we're about through, Dr. Gentry.
MS. FORBES: Why don't we take about a five-minuter.
(RECESS TAKEN FROM 2:25 P.M. TO 2:30 P.M.)

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BY MR. LEE:

Q: Dr. Gentry, I put in the inside story relative to Eclipse, and this is just - I'll mark it as 16 - is just a copy of the nicotine and tar on the Eclipse. Do you recognize that?

(EXHIBIT NUMBER 16 WAS MARKED FOR IDENTIFICATION)

A: Looks like a photocopy of the side of a cigarette package of Eclipse.

MR. LEE: Okay. I offer that as exhibit 16.

Q: And you mentioned earlier that you thought the Eclipse was .3 milligrams. Could that have been .2 milligrams?

A: Yes. I think I estimated it -

Q: You did. You said that. And I wasn't looking at that - I think I was looking at the time. It hasn't changed? In other words, it's probably stayed at .2, hasn't it?

A: To my knowledge, for whatever - there's two styles. There's a - I'm not sure what they call them - a full flavor or lights. There's two styles, and I don't know if the nicotine levels are the same.

Q: And the tar is 3 milligrams and the average cigarette is 12 milligrams?

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A: That's what's here, yes.

Q: And nicotine .2 milligrams with average cigarette being .9 milligrams?

A: Yes, sir, that's what's shown here.

Q: Now, without repeating what we've talked about all day, however, the idea of a lower tar and lower nicotine is an attempt, at least, to turn out a safer cigarette or a cigarette with reduced health risk?

MS. FORBES: Objection to the form.

THE WITNESS: I believe that throughout my testimony, I've tried to convey that R.J. Reynolds has been very proactive in addressing allegations against the industry. We have significantly reduced tar over the years. We have proactively sought to reduce many chemical constituents in cigarette smoke. And I don't know how to further characterize that.

MR. LEE: Okay. That's all we have.

MS. FORBES: I just briefly have a few.

CROSS EXAMINATION
BY MS. FORBES:

Q: Dr. Gentry, do you recall during Mr. Lee's questioning he asked you to provide a definition of a drug? Do you recall that earlier this morning?

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A: Yes, I do.

Q: Okay. And I believe - well, do you recall how you defined it, drug?

A: I believe I testified that I wasn't an expert in that area or a druggist, but my naive interpretation of that would be that it was a material or agent that was physiologic - had a physiological or pharmacological effect.

Q: And even though you're not an expert in that area, would you agree that that's a rather broad definition?

A: Yes.

Q: And under the definition that you use, when you use the definition, many things have physiological or pharmacological effects?

A: Yes.

Q: Would you include caffeine, for example, as something that would meet that definition?

A: Yes. Caffeine, yes.

Q: And in determining whether something has a physiological or a pharmacological effect, would you also want to consider the dose of that agent in making an evaluation of its effect?

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A: I believe that would be important. I believe there's a level below something wouldn't have an effect. Or it may have at higher levels.

MS. FORBES: I don't have any further questions. I want the record to reflect that pursuant to paragraph 11 of the protective order, confidential materials have been discussed during the deposition, and the procedures thereto will be followed.

MR. LEE: Okay. And I'm going to repeat that should there be anything in the materials that the office coordinating Arch in Philadelphia is furnished, relative to something like 330,000 pieces maybe - that's what it indicated - and should that be, and should after reviewing this deposition, then we might ask that it continue. I don't anticipate that, however, we might.

MS. FORBES: Thank you for your time, Dr. Gentry. That concludes this deposition.

(SIGNATURE RESERVED)

(DEPOSITION CONCLUDED AT 2:45 P.M.)

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JURAT

I, Jeffery S. Gentry, Ph.D., do hereby certify that I have read the foregoing transcript of my testimony, taken on May 21, 1997, and have signed it subject to the following changes:

PAGE	LINE	CORRECTION

Sworn and subscribed to before me on this ___ day of

NOTARY PUBLIC _____

STATE OF NORTH CAROLINA
COUNTY OF FORSYTH

REPORTER'S CERTIFICATE

I, Elizabeth S. Girvan, a Notary Public in and for the State of North Carolina, do hereby certify that there came before me on Wednesday, May 21, 1997, the person hereinbefore named, who was by me duly sworn to testify to the truth and nothing but the truth of his knowledge concerning the matters in controversy in this cause; that the witness was thereupon examined under oath, the examination reduced to typewriting under my direction, and the deposition is a true record of the testimony given by the witness.

I further certify that I am neither attorney or counsel for, nor related to or employed by, any attorney or counsel employed by the parties hereto or financially interested in the action.

IN WITNESS WHEREOF, I have hereto set my hand and affixed my official notarial seal, this the 4th day of June 1997.

Elizabeth S. Girvan, Notary Public
My Commission Expires March 5, 2000

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Lawyer's Notes

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Lawyer's Notes

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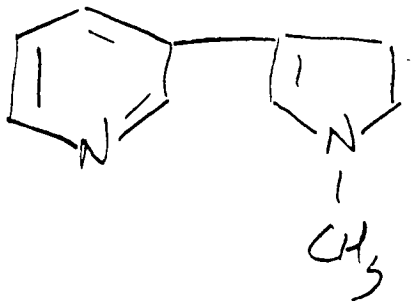
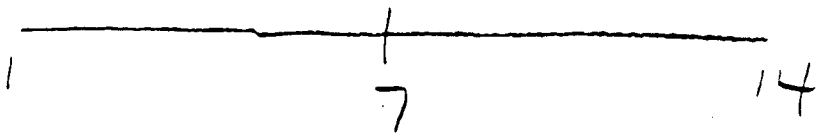
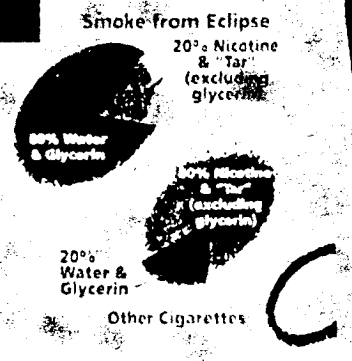




It's simple.

Eclipse primarily heats tobacco instead of burning it. That's how it reduces second-hand smoke by close to 90%. It's made like other cigarettes, with a special difference: a high-purity carbon tip, wrapped in a heat barrier that keeps Eclipse from burning down. You light the tip and, as you draw, warm air passes over the tobacco, creating a full-bodied, satisfying smoke.



There's nothing in Eclipse smoke that isn't in the smoke of other cigarettes. Yet it is different. Smoke particles from other cigarettes are about 20% water and glycerin. But Eclipse is the reverse. It's about 80% water and glycerin (glycerin is found in all cigarette smoke and many foods). That's why Eclipse smoke disappears so fast.

EXHIBIT NO. 4
Wit: KENTICH
Date: 5/21/97
Rptr:

It's easy.

To light Eclipse, take an extra puff and a longer draw while holding a flame to the carbon tip. (A car lighter won't work.)

Before Lighting

After Smoking

Eclipse never gets shorter. You know it's finished when there's less smoke and the taste gets weaker.

It's incredible.

Discover the pleasure of Eclipse, the ultra-low tar cigarette with full-bodied taste and close to 90% less second-hand smoke. There's no lingering odor, hardly a stain, not even ashes.

Eclipse. The smoke vanishes. The pleasure lingers.™

Questions? Comments? Call 1-800 828-1400

ECLIPSE

The Inside Story

51696 0921

US005415186A

United States Patent [19]

Casey, III et al.

[11] Patent Number: 5,415,186

[45] Date of Patent: * May 16, 1995

[54] SUBSTRATES MATERIAL FOR SMOKING ARTICLES

[75] Inventors: William J. Casey, III, Clemmons; Jeffery S. Gentry, Pfafftown; Alvaro Gonzalez-Parra, Clemmons; Aju N. Lekwauwa, Winston-Salem; Dennis M. Riggs, Belews Creek; Gary R. Shelar, Greensboro; Kenneth W. Swicegood, Lexington; Ronald O. Wagoner, Winston-Salem; Jeffrey A. Willis, Germanton; Walter R. D. Young, Jr., Winston-Salem; Kelly K. Hutchison, Kernersville, all of N.C.

[73] Assignee: R. J. Reynolds Tobacco Company, Winston-Salem, N.C.

[*] Notice: The portion of the term of this patent subsequent to Apr. 7, 2009 has been disclaimed.

[21] Appl. No.: 49,057

[22] Filed: Apr. 16, 1993

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 800,679, Nov. 27, 1991, which is a continuation of Ser. No. 567,519, Aug. 15, 1990, Pat. No. 5,101,839.

[51] Int. Cl.[6] A24D 1/18

[52] U.S. Cl. 131/194; 131/343; 131/365

[58] Field of Search 131/335, 343, 194, 365

[56] References Cited

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(List continued on next page.)

Primary Examiner—Mark S. Graham
Assistant Examiner—William M. Pierce
Attorney, Agent, or Firm—Grover M. Myers; David G. Conlin

[57] ABSTRACT

Disclosed is a stabilized substrate composition for smoking articles, particularly cigarettes. In general, the stabilized substrate composition comprises an admixture of a binder and an aerosol forming material which plasticizes the binder, together with optional fillers and/or base materials. In the stabilized substrate compositions of the present invention the relative amounts of binder and aerosol former depend particularly on the situation in which the substrate composition is used. In general, the ratio of aerosol former to binder is between about 3:1 and about 40:1. When the stabilized composition is used on a base material such as tobacco cut filler, the ratio of aerosol former to binder should be at least about 15:1, and preferably is from about 25–35:1, with a maximum ratio of about 40:1. If the composition is formed into a cast sheet, the minimum ratio is about 3:1, the preferred ratio is about 8:1, and the maximum ratio is about 10:1. When the stabilized mixture is printed on a sheet or web substrate, the ratio of aerosol former to binder is generally about 6:1, the maximum ratio is about 10:1, and the minimum ratio is about 3:1.

55 Claims, 2 Drawing Sheets

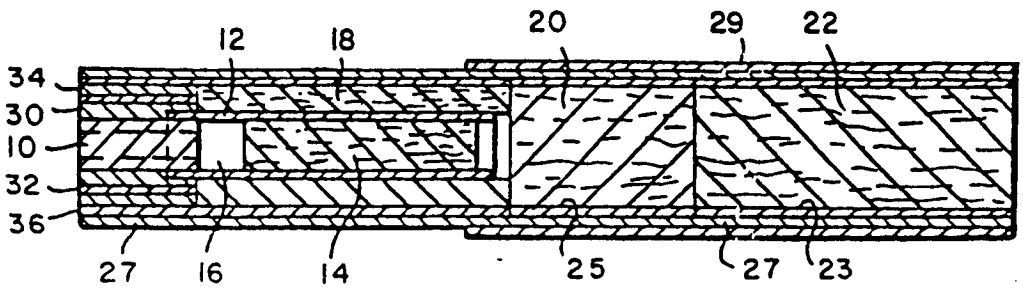

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EXHIBIT NO. 5
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Date: 5-21-97
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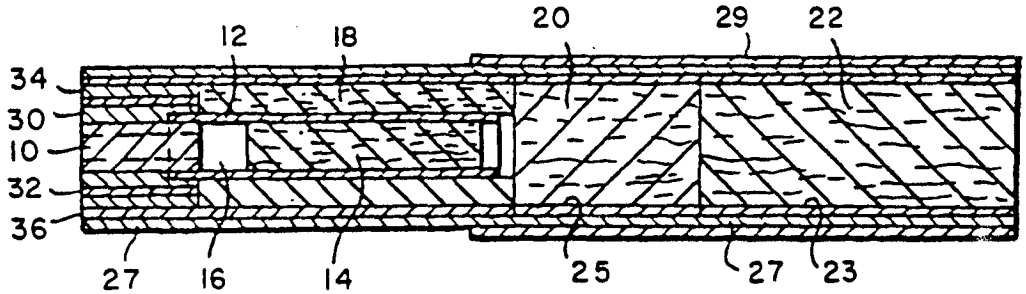

FIG. 1

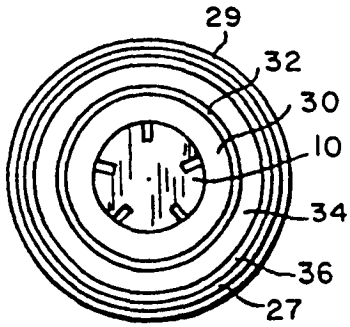

FIG. 1A

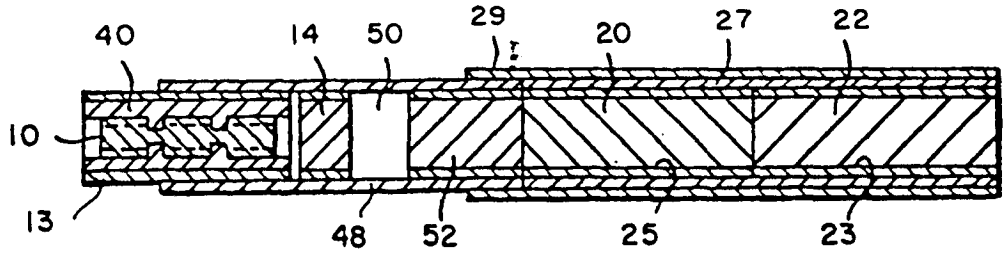

FIG. 2

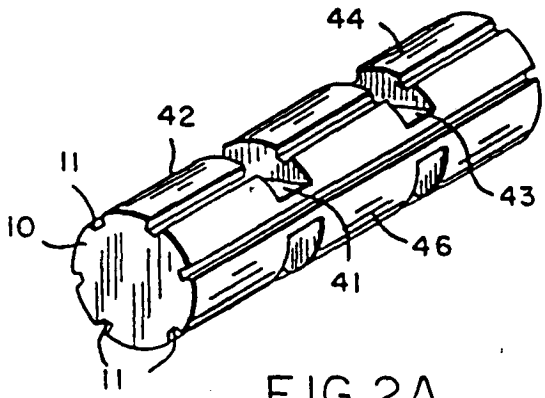

FIG. 2A

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SUBSTRATES MATERIAL FOR SMOKING ARTICLES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of co-pending application Ser. No. 07/800,679, filed Nov. 27, 191, still pending, which is a continuation of application Ser. No. 07/567,519, filed Aug. 15, 1990, now U.S. Pat. No. 5,101,839, the disclosure of which is hereby incorporated herein by reference.

FIELD OF THE INVENTION

The present invention is directed to improvements in smoking articles, particularly smoking articles employing tobacco therein. Cigarettes, cigars and pipes are popular smoking articles which use tobacco in various forms. Many smoking products have been proposed as improvements upon, or alternatives to, the various popular smoking articles. For example, numerous references have proposed articles which generate a flavored vapor and/or a visible aerosol. Most of such articles have employed a combustible fuel source to provide an aerosol and/or to heat an aerosol forming material. See, for example, the background art cited in U.S. Pat. No. 4,714,082 to Banerjee et al.

BACKGROUND OF THE INVENTION

The present invention relates to smoking articles such as cigarettes, and in particular to those smoking articles having a short fuel element and a physically separate aerosol generating means. Smoking articles of this type, as well as materials, methods and/or apparatus useful therein and/or for preparing them, are described in the following U.S. Pat. Nos. 4,708,151 to Shelar; No. 4,714,082 to Banerjee et al.; No. 4,732,168 to Resce; No. 4,756,318 to Clearman et al.; No. 4,782,644 to Homer et al.; No. 4,793,365 to Sensabaugh et al.; No. 4,802,562 to Homer et. al.; No. 4,827,950 to Banerjee et al.; No. 4,870,748 to Hensgen et al.; No. 4,881,556 to Clearman et al.; No. 4,893,637 to Hancock et al.; No. 4,893,639 to White; No. 4,903,714 to Barnes et al.; No. 4,917,128 to Clearman et al.; No. 4,928,714 to Shannon; No. 4,938,238 to Hancock et al., No. 4,989,619 to clearman et al., No. 5,027,837 to Clearman et al., and No. 5,038,802 to White et al., as well as in the monograph entitled *Chemical and Biological Studies of New Cigarette Prototypes That Heat Instead of Burn Tobacco*, R.J. Reynolds Tobacco Company, 1988 (hereinafter "RJR Monograph"). These smoking articles are capable of providing the smoker with the pleasures of smoking (e.g., smoking taste, feel, satisfaction, and the like). Such smoking articles also typically provide low yields of visible sidestream smoke as well as low yields of FTC tar when smoked.

The smoking articles described in the aforesaid patents and/or publications generally employ a combustible fuel element for heat generation and an aerosol generating means, positioned physically separate from, and typically in a heat exchange relationship with the fuel element. Many of these aerosol generating means employ a substrate or carrier for one or more aerosol forming materials, e.g., polyhydric alcohols, such as glycerin. As the substrate material is heated by the burning of the fuel element, the aerosol forming materials are volatilized and released therefrom to form an aerosol.

The substrates used previously have included heat stable materials, i.e., materials which do not burn or decompose appreciably when subjected to the heat generated by the burning fuel element. Such materials include adsorbent carbons, such as porous grade carbons, graphite, activated carbons, or non-activated carbons, and the like. Other heat stable materials include inorganic solids, such as ceramics, glass, alumina, vermiculite, clays such as bentonite, and the like.

Other substrate materials used previously have included cellulosic materials, e.g., paper, tobacco paper and the like. These materials typically require a large amount of aerosol former to be present on the substrate to prevent scorching. The presence of large amounts of aerosol former also tends to promote migration of aerosol former from the substrate to other components of the smoking article.

It would be advantageous to have a substrate for smoking articles, particularly cigarettes, which could be manipulated using conventional cigarette making equipment, and which would hold sufficient aerosol forming material to provide aerosol over the 10–12 puff life of a cigarette. It would also be desirable that such a substrate would be stable during storage, i.e., the aerosol former would not appreciably migrate therefrom, to the other parts of the smoking article. These and other desirable attributes of smoking articles, and particularly cigarettes, are provided by the smoking articles of the present invention, which are described below.

SUMMARY OF THE INVENTION

It has been discovered that polyhydric alcohol (polyol) aerosol forming materials, such as glycerin, propylene glycol, and the like, can be stabilized by the use of certain binders. It has further been discovered that these stabilized mixtures are useful in certain smoking articles, particularly those smoking articles, such as cigarettes employing a short fuel element and a physically separate aerosol generating means for the production of a smoke-like aerosol.

In particular, it has been discovered that aerosol forming materials can be intimately incorporated in a binder to form a stable product of admixture, from which migration of the aerosol former is minimized, particularly over long periods of time, e.g., under typical storage conditions. Such stable mixtures are sprayable, printable, castable, extrudable, or densifiable. Such mixtures may be used with a substrate base or substrate material, or may be used alone to form a substrate for smoking articles. Upon exposure to heat, e.g., from the burning fuel element of a smoking article, the aerosol forming substance is released to form an aerosol. While not wishing to be bound by theory, it is believed that the aerosol forming materials useful herein serve as plasticizers for the binder. As with all true plasticizers, the aerosol former is a relatively nonvolatile solvent (at room temperatures) for the resinous substance (i.e., the binder) that, when compounded with the binder, increases its flexibility, workability or shock resistance. See, *The Technology of Solvents and Plasticizers*, Chapter 15, "Plasticizers and Plasticization," John Wiley & Sons, New York (1954), the disclosure of which is hereby incorporated herein by reference.

In the stabilized substrate compositions of the present invention the relative amounts of binder and aerosol former depend on the situation in which the substrate

to stabilize the other components, preventing migration of the polyol. An especially preferred binding agent is an alginate, such as ammonium alginate. Advantageously, when tobacco materials are used in the mixture, a cross-linking destruction or releasing agent can be used to liberate the natural binders present in the tobacco (e.g., pectinaceous materials). These released naturally occurring binders may then be used to stabilize the aerosol forming materials. A combination of binders, e.g., released natural tobacco binders and added binders (e.g., alginates) may be used if desired.

The substrate mixture can also include optional flavoring agents (e.g., cocoa, licorice, organic acids, menthol, tobacco based flavors, and the like.) Preferably the flavorants are added in liquid or spray dried form, preferably at the same time as or after the addition of the aerosol forming material to the binder/water mixture. Alternatively, the flavoring agents can be dry mixed with the material at other stages of the process.

The substrate mixture can be cast as a sheet from an aqueous slurry, extruded, molded or otherwise formed into the desired sheet form. Such a substrate can be employed in gathered web form, shredded and gathered into a rod, or used in the form of cut filler. It can be used as the sole substrate of a cigarette or, alternatively, this substrate can be physically mixed with or otherwise employed with other substrate materials, such as tobacco cut filler or inorganic substrates, to form a heterogeneous substrate mixture, or a series of substrate segments. In another embodiment of the present invention, flavoring agents such as menthol are directly incorporated in the substrate composition. One method for directly incorporating menthol involves the formation of an aqueous slurry containing a binder, an aerosol forming material, and a menthol-containing organic or inorganic filler material. An especially preferred organic filler material for use with menthol is activated carbon, treated to retain from about 1 to about 50 weight percent, preferably from about 5 to about 30 weight percent menthol. The carbon/menthol mixture may be prepared by milling activated carbon with solid menthol. During the milling, the menthol vaporizes (or sublimes) and the activated carbon adsorbs and/or absorbs the menthol.

The carbon/menthol slurry generally includes from about 40 to about 90 weight percent of one or more aerosol forming materials (e.g., polyols, such as glycerin and/or propylene glycol). The slurry also includes from about 5 to about 15 weight percent of a binding agent, which serves to stabilize the other components, preventing migration of the flavor material and/or the aerosol forming materials. An especially preferred binding agent is an alginate, such as ammonium alginate.

The slurry may be cast onto a substrate sheet material as described above for the other substrate compositions and air dried under ambient-conditions to drive off excess moisture. This substrate composition can be shredded into cut filler or made into a gathered web. This composition as cut filler or gathered web can be made into 7.5 mm diameter paper wrapped rods and cut into 10 mm sections to be used as substrates. Other components can be included in the slurry, e.g., tobacco, inorganic fillers, and the like. As the skilled artisan will appreciate, depending upon the thickness of the slurry, the handling thereof can be varied. For instance, a dilute slurry can be sprayed or printed onto a substrate base material. A slightly thicker slurry can be cast into a sheet form. Still thicker slurries can be extruded and/or densified to form a suitable substrates.

In those preferred embodiments where ammonium alginate is used as a stabilizing binder, it is preferable to add a sequestering agent, such as potassium carbonate, potassium acetate, or other known sequestering agent, to exert some control over the alginate polymerization process.

Regardless of the shape, form or compositional make-up in which it is employed, the substrate material of this invention retains the aerosol forming materials during storage, and releases the materials gradually during smoking. Temperatures as low as from about 180° to 200° C. are typically sufficient to cause a release of the aerosol former, thereby minimizing the amount of fuel necessary for the smoking device.

It has been discovered that low viscosity binders are most useful in those applications where the stabilized mixture is to be sprayed, while high viscosity binders are most useful in those applications where the stabilized mixture is to be cast or otherwise formed into a sheet or web structure. There appears to be no significant difference in the holding power (i.e., as to the binding or retention of the aerosol former) between the high viscosity and the low viscosity binders. As the skilled artisan will appreciate from this disclosure, the most preferred binders are those which will effectively hold a large quantity of aerosol former.

Preferred substrates of the present invention provide tobacco taste, permit little or no migration of the aerosol former, are simple to manufacture, and are easy to incorporate into smoking articles using conventional equipment. The substrates provide adequate quantities of aerosol during use, provide a large number of puffs, with high aerosol content, in the typical cigarette structures employing the substrate. The substrates of the present invention, in various cigarette structures, provide the opportunity to avoid use of metallic heat conductors, such as the aluminum conductive structures used in some prior cigarettes, and to avoid anti-migration measures previously utilized in certain smoking article structures, such as the spacing of the aerosol generating means from the fuel element, and the like. The present substrates are not only stable, but they are lighter in weight than certain prior substrate materials, and provide other advantages as well.

As used herein, the term "aerosol" is meant to include vapors, gases, particles, and the like, both visible and invisible, and especially those components perceived by the smoker to be "smoke-like," formed by the action of heat generated by the fuel element upon materials contained within the aerosol generating means, or elsewhere in the smoking article.

As used herein, the term "carbonaceous" means comprising primarily carbon.

All weight percentages given herein are based on the final composition weights, unless otherwise noted.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional illustration of one configuration of a cigarette having the substrate composition prepared according to the present invention.

FIG. 1A is an end view of the cigarette shown in FIG. 1.

FIG. 2 illustrates in sectional view, another embodiment of a cigarette which may employ the substrate of the present invention.

In use, the smoker lights fuel element 10 (e.g., using a cigarette lighter) and the burning segment 30 burns to produce heat. During draw, air passes along the periphery of the burning segment 42 (including down channels 11) as well as through the retaining and insulating jacket 40. The drawn air is heated by contacting the burning segment of the fuel element and by heat radiated from the fuel element. The heated air transfers heat by convection to the substrate 14 and this transferred heat volatilizes the aerosol forming and flavor materials carried by the substrate. The volatilized material within the hot drawn air exits the substrate and then cools during passage through void space 50, forming an aerosol. The aerosol passes through the tobacco or tobacco papers 52 and 20 absorbing additional tobacco flavors, and passes through the filter material 22, and into the mouth of the smoker. Since the base portion of the fuel element 44 does not burn during the use of the cigarette, the fuel element remains securely in the cigarette and does not have a tendency to become dislodged from the cigarette during use. When the fuel element self-extinguishes and no longer generates heat, the cigarette is disposed of.

As illustrated in FIGS. 1 & 2, the substrate is positioned behind the fuel element, in a spaced apart relationship relative to the back end of the fuel element so as to have an air space or gap therebetween. This can be accomplished by abutting the substrate against the insulating jacket or by providing a gap or space between the jacketed fuel element and the substrate during manufacture. Such a gap is typically provided to prevent scorching of the substrate materials by the hot gases emanating from the rear of the burning fuel element. This gap also assists in preventing migration of the aerosol forming materials from the aerosol generating means to other components of the cigarette, particularly the fuel element. If desired, the back end of the fuel element and the front end of the substrate may be spaced from about 1 mm to about 10 mm apart, preferably from about 2 mm to about 5 mm apart.

As illustrated in FIG. 2, another void space may also be provided immediately behind the substrate. Such a void space can provide a zone for aerosol formation, and is preferably from about 1 to about 20 mm in length. Such an aerosol forming zone is typically located forward of any tobacco cut filler, tobacco paper or the like, so that the aerosol may pass therethrough and absorb tobacco flavors.

FIG. 3 illustrates another embodiment of a cigarette which can utilize the substrates of the present invention. As illustrated, a multi-part insulating and retaining jacket circumscribes the longitudinal periphery of fuel element 10 and extends beyond each end of the fuel element, such that the fuel element is recessed within the insulating and retaining jacket. As illustrated in FIG. 3A, the multi-part insulating jacket comprises alternating layers of C-glass fibers and tobacco paper, arranged as concentric rings emanating outwardly from the fuel element in the following order; (a) C-glass 62; (b) tobacco paper 64; and (c) C-glass 66; and an outer paper wrapper 13.

Situated immediately behind the insulated fuel element 10, i.e., in an abutting end-to-end relationship, is the aerosol generating means, which comprises a substrate 14, prepared as described herein. In this embodiment, which is most preferred, the stabilized nature of the substrate composition, in conjunction with the recessed nature of the fuel element 10 within insulating jacket, are factors which help to prevent migration of the aerosol forming materials out of the aerosol generating means into other components of the cigarette. The substrate 14 holds one or more stabilized aerosol forming materials and optional flavor components, which are volatilized by heat generated by the burning of the fuel element.

The wrapper 13 is an air permeable wrapper, which may comprise one layer or it may be prepared from two separate layers, each having different porosity and ash stability characteristics. Circumscribing the insulated fuel element, at a point about 2 to 8 mm from the lighting end of the cigarette, is a non-burning or foil-backed (e.g., aluminum or other metal) paper wrapper 48. Wrapper 48 is preferably a non-wicking material which prevents the wicking of the aerosol forming material(s) on the substrate 14 to the fuel element 10, the insulating jacket, and/or from staining of the other components of the front end assembly. This wrapper also minimizes or prevents peripheral air (i.e., radial air) from flowing to the portion of the fuel element disposed longitudinally behind its forward edge, thereby causing oxygen deprivation and preventing excessive combustion. While not preferred, wrapper 48 may extend over the burning end of the fuel element 10 (or beyond the same) and be provided with a plurality of perforations (not shown) to allow controlled radial air flow to the burning segment of the fuel element to support combustion.

Situated longitudinally behind substrate 14 is a segment of tobacco paper 68. This tobacco paper generally provides tobacco flavors to the aerosol emitted from the aerosol generating means.

Positioned at the extreme mouth end of the cigarette is a two part mouthend piece comprising (i) a rod or roll of tobacco, such as tobacco cut filler 20 and (ii) a low-efficiency filter element 22 including a filter material, such as a gathered web of non-woven polypropylene fibers.

Each of the above described elements of the cigarette of the present invention is generally provided with a paper overwrap, and individual overwrapped segments are typically combined by the use of paper overwraps. Advantageously, the paper overwrap of the substrate is a non-wicking paper. These papers are shown in FIG. 3 as reference numbers 23–26. A tipping paper 29 is used to join the mouthend piece to the front end assembly.

In use, the smoker lights fuel element 10, e.g., using a cigarette lighter, and the fuel burns to produce heat. During draw, air passes along the periphery of the burning fuel element 10, as well as through the retaining and insulating jacket. The drawn air is heated by contacting the burning segment of the fuel element and by heat radiated from the fuel element. The heated air transfers heat by convection to the substrate 14 and this transferred heat volatilizes the aerosol forming and flavor materials carried by the substrate. The volatilized material forms an aerosol during its progression through the substrate, which aerosol is then drawn through the other components during smoking. The aerosol passes through the tobacco or tobacco papers 68 and 20 absorbing additional tobacco flavors, and passes through the filter material 22, and into the mouth of the smoker.

As described in the illustrated embodiments, the aerosol generating means includes a substrate for carrying the aerosol forming material. The substrates of the present invention typically comprises a base material which serves as a carrier, and a stabilized aerosol forming substance, which is generally referred to herein as the

strate base material, such as tobacco cut filler, or the like; (2) printing or otherwise forming a film of the stabilized aerosol former/binder mixture onto a solid base material, such as reconstituted tobacco paper, other papers (e.g., wood pulp containing materials) and the like; (3) by casting a slurry comprising the stabilized aerosol former/binder mixture and one or more filler materials, e.g., an inorganic filler (e.g., $CaCO_3$) and/or an organic filler (e.g., tobacco) into a sheet, and drying the cast material to form a relatively, dry workable sheet; (4) extruding a relatively thick slurry into discretely shaped particles, which may also include one or more passageways or channels therein or thereon, for modification of the surface area; and/or (5) a densified product, wherein an extruded stabilized mixture is treated to one or more processes which increase the density thereof, e.g., by the application of centrifugal force. See, for example U.S. Pat. No. 4,893,639 to White.

Other materials, such as calcium acetate, potassium carbonate, pH control agents, urea, amino acids, potassium chloride and/or calcium hydroxide, can be incorporated into the castable slurry, if desired. Techniques and equipment for forming substrates of this type by spraying, printing, casting, extruding and/or densifying are all commercially available, and will be readily apparent to the skilled artisan.

When ammonium alginate binders are employed in the cast sheet type compositions of the present invention, sequestering agents may preferably be added thereto. Sequestering agents (e.g., diammonium hydrogen orthophosphate, sodium citrate, potassium carbonate, potassium citrate, potassium hexametaphosphate, tetrasodium pyrophosphate, and the like) are typically incorporated into the substrate composition slurry in amounts sufficient to control the free calcium ion concentration in the slurry.

The formed substrate material can be dried at ambient temperatures or at slightly elevated temperatures, sufficient to drive off excess water, but without driving off desired components, e.g., the aerosol forming materials, flavor components, and the like. If desired, an aqueous solution of calcium salts can be applied to the substrates after formation.

The most preferred substrate compositions of the present invention have some form of tobacco incorporated therein during manufacture. The tobacco can have a variety of forms, including tobacco extracts, tobacco fines or dust, shredded or comminuted tobacco laminae, tobacco stems, volume expanded tobacco filler and other processed forms of tobacco, and the like, and combinations thereof.

One form of tobacco especially useful herein is tobacco cut filler (e.g., strands or shreds of tobacco filler having widths of about 1/15 inch to about 1/40 inch, and lengths of about ¼ inch to about 3 inches). Tobacco cut filler can be provided in the form of tobacco laminae, volume expanded or puffed tobacco laminae, processed tobacco stems including cut-rolled or cut-puffed stems, or reconstituted tobacco material.

Processed tobaccos, such as those described in U.S. Pat. No. 5,025,812 to Fagg et al., or U.S. Pat. Nos. 4,065,775 to Fagg and No. 5,131,414 to Fagg et al. can also be employed. Reconstituted tobacco material can be provided using cast sheet techniques such as those provided in U.S. patent application Ser. No. 07/461,216, filed Jan. 5, 1990; or by papermaking techniques, such as those described in U.S. Pat. Nos. 4,962,774 to Thomassen et al. and No. 4,987,906 to Young et al., as well as in U.S. patent application Ser. Nos. 07/647,329, filed Jan. 28, 1991; or extrusion techniques, such as are described in U.S. Pat. No. 4,821,749 to Toft et al.; or by volume expansion techniques, such as those described in U.S. patent application No. 5,095,922. Other reconstituted tobacco materials useful in the cigarettes of the present invention are prepared using processes described in U.S. patent application Ser. No. 07/710,273, filed Jun. 4, 1991.

Cut filler, prepared as described herein as a substrate, is generally incorporated into the cigarette as a cylindrical roll or charge of tobacco material which is wrapped in a circumscribing paper wrapper. Tobacco cut filler can be provided as a roll in a paper wrapper using cigarette rod making techniques and apparatus which are well known by the skilled artisan.

Another form of tobacco useful herein is tobacco paper. For example, a web of tobacco paper available as P-144-GNA from Kimberly-Clark Corp. can be gathered into a cylindrical segment in a manner set forth in Example 2 of U.S. Pat. No. 4,807,809 to Pryor et al.

Another form of tobacco useful herein is finely divided tobacco material. Such a form of tobacco includes tobacco dust and finely divided tobacco laminae. Typically, finely divided tobacco material is carried by the substrate which is positioned within the aerosol generating means. However, finely divided tobacco material also can be incorporated into the fuel element.

Another form of tobacco useful herein is tobacco extract. Tobacco extracts are typically provided by extracting a tobacco material using a solvent such as water, carbon dioxide, sulfur hexafluoride, a hydrocarbon such as hexane or ethanol, a halocarbon such as a commercially available Freon, as well as other organic and inorganic solvents. Tobacco extracts can include spray dried tobacco extracts, freeze dried tobacco extracts, tobacco aroma oils, tobacco essences and other types of tobacco extracts. Methods for providing suitable tobacco extracts are set forth in U.S. Pat. Nos. 4,506,682 to Mueller, No. 4,986,286 to Roberts et al., No. 5,005,539 to Fagg, No. 5,060,669 to White et al., No. 5,121,757 to White et al., and No. 5,131,415 to Munoz et al. and European Patent Publication No. 338,831; and U.S. patent application Ser. Nos. 07/452,175, filed Dec. 18, 1989, No. 07/536,250, filed Jun. 11, 1990, No. 07/680,207, filed Apr. 4, 1991, No. 07/709,959, filed Jun. 4, 1991, No. 07/710,273, filed Jun. 4, 1991, and No. 07/717,457, filed Jun. 19, 1991.

Also useful are flavorful tobacco compositions such as those described in U.S. Pat. No. 5,016,654 to Bernasek et al. Another form of tobacco is enzymatically treated tobacco extract. This extract is described in U.S. patent application Ser. Nos. 07/721,860, filed Jun. 21, 1991, and No. 07/746,252, filed Aug. 15, 1991.

Preferred substrate compositions of the present invention normally include at least about 15, usually at least about 20, often at least about 25, frequently at least about 30, and sometimes at least about 40 weight percent aerosol forming material. Typically, the substrate composition includes up to about 70, and usually up to about 60 weight percent aerosol forming material. The substrate composition also typically includes up to about 20, preferably about 3 to about 15 weight percent binding agent; and up to about 80 percent preferably about 40 to about 75 weight percent filler component in particular, the filler component can include an organic filler material (e.g. tobacco dust or milled tobacco lami-

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preferably about 8–12 puffs; and (3) they should not contribute off-taste or unpleasant aromas to the cigarette. Fuel elements prepared from a combustible composition comprising carbon and a binder, or carbon, tobacco and a binder are preferred, but other combustible compositions may be used.

If desired, a non-burning filler material such as calcium carbonate, agglomerated calcium carbonate, or the like, may be added to the fuel composition to assist in controlling the calories generated by the fuel element during combustion, by reducing the amount of combustible material present therein. The filler material typically comprises less than about 50 weight percent of the fuel composition, preferably less than about 30 weight percent, and most preferably from about 5 to about 20 weight percent. See, U.S. patent application Ser. No. 07/567,520, filed Aug. 15, 1990.

Preferred fuel elements used herein comprise carbonaceous materials. The preferred carbonaceous materials have a carbon content above about 60 weight percent, more preferably above about 70 weight percent, and most preferably above about 80 weight percent. Flavors, tobacco materials, fillers (e.g. clays or calcium carbonate), burn additives, combustion modifying agents, and the like, may be incorporated into the fuel element.

The density of the preferred fuel elements is generally greater that about 0.5 g/cc, preferably greater than about 0.7 g/cc and most preferably greater than about 1 g/cc, but typically does not exceed 2 g/cc. The length of the fuel element, prior to burning, is generally less than about 25 mm, often less than about 17 mm, and is typically about 10–12 mm or less.

Exemplary compositions of carbonaceous fuel elements are set forth in U.S. Pat. Nos. 4,714,082 to Banerjee et al.; as well as in European Patent Publication Nos. 236,992 and 407,892; which are incorporated herein by reference. Other exemplary carbonaceous materials are coconut hull carbons, such as the PXC carbons and the PCB carbons, as well as the experimental carbons available as Lot B-11030-CAC-5, Lot B-11250-CAC-115 and Lot 089-A12-CAC-45, from Calgon Carbon Corp.

Other fuel elements can be provided from comminuted tobacco material, reconstituted tobacco material, heat treated or pyrolyzed tobacco materials, cellulosic materials, modified cellulosic materials, and the like. Exemplary materials are set forth in U.S. Pat. No. 3,931,824 to Miano et al., as well as in U.S. patent application Ser. No. 07/569,325, filed, Aug. 17, 1990, and in Sittig, *Tobacco Substitutes*, Noyes Data Corp. (1976).

One suitable fuel composition comprises from about 60 to about 99 weight percent carbon; from about 1 to about 20 weight percent of a suitable binder; from about 1 to about 5 weight percent of an ammonia releasing compound; and from about 2000 to about 20,000 ppm sodium (Na) as measured using inductively coupled plasma atomic emission spectroscopy (ICP-AES). Compounds capable of releasing ammonia under the burning conditions of the fuel composition include compounds such as urea, inorganic and organic salts (e.g., ammonium carbonate, ammonium alginate, or mono-, di-, or tri-ammonium phosphate); amino sugars (e.g., prolino fructose or asparigino fructose); amino acids, particularly alpha amino acids (e.g., glutamine, glycine, asparagine, proline, alanine, cystine, aspartic acid, phenylalanine or glutamic acid); di-, or tri-peptides; quaternary ammonium compounds, and the like. These fuel compositions are described in detail in Riggs et al., U.S. patent application Ser. No. 07/722,993, filed Jun. 28, 1991, the disclosure of which is hereby incorporated herein by reference.

The carbonaceous fuel elements for smoking articles of the present invention may be molded, machined, pressure formed or extruded into the desired shape. Molded fuel elements can have channels, slots, grooves or hollow regions therein.

Preferred extruded carbonaceous fuel elements can be prepared by admixing up to 95 parts carbonaceous material, up to 20 parts binder and up to 20 parts tobacco (e.g., tobacco dust and/or a tobacco extract) with sufficient water (or aqueous Na_2CO_3 solution) to provide an extrudable mixture. This mixture can then be extruded using a ram, screw or piston type extruder into an extrudate of the desired shape having the desired number of channels or void spaces.

If desired, the fuel element can be at least partially circumscribed by a liner, such as at least one layer of paper, which surrounds the peripheral length of the fuel element (see FIG. 2). As such, the liner is positioned between the fuel element and the inner surface of the insulating and retaining material. Preferably, the one or two layers of liner extend along the length of the inner surface of the insulating and retaining material. Most preferably, the liner completely circumscribes the fuel element and extends along the total length of the inner surface of the insulating and retaining member. The liner most preferably is a tobacco paper (e.g., a tobacco/wood pulp paper available as P-2831-189-AA from Kimberly-Clark) or a carbon-containing paper (e.g., a carbon—wood pulp—tobacco stem paper available as P-2540-136E from Kimberly-Clark).

When employed in a cigarette, the fuel element(with or without a liner) is circumscribed by an insulating and/or retaining jacket material. The insulating and retaining material preferably (i) is adapted such that drawn air can pass therethrough, and (ii) is positioned and configured so as to hold the fuel element in place. In some embodiments, the insulating and/or retaining material is compressed around the fuel element, thereby ensuring a good, stable positioning and snug fit of the fuel element therein.

In the cigarettes of the present invention, the fuel element may be recessed within the insulating and/or retaining jacket. The length of the jacket extending beyond each end of the fuel element may be as long or as short as desired for producing various burning and heat transfer characteristics. The jacket may be flush with the ends of the fuel element or it may extend from about 0.5 mm to about 3 mm, preferably from about 1 to 2.5, and most preferably from about 1.5 to 2 mm beyond each end of the fuel element.

The components of the insulating and/or retaining material which surrounds the fuel element can vary. This material is preferably one which has a tendency not to combust or a material which combusts but does not disintegrate. Examples of suitable materials include glass fibers and other materials of the type described in U.S. Pat. No. 5,105,838; European Patent Publication No. 339,690; and pages 48–52 of the RJR Monograph, supra.

Examples of other suitable insulating and/or retaining materials are glass fiber and tobacco mixtures such as are described in U.S. Pat. No. 4,756,318 to Clearman et al. and U.S. Pat. Nos. 5,065,776 to Lawson et al. and No. 5,105,838 to White et al. and No. 07/601,551, filed, Oct. 23, 1990.

described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor et al.

The entire length of the smoking article, or any portion thereof, can be overwrapped with cigarette paper. Preferred papers of the FIG. 1 type cigarettes, e.g., which circumscribe the heat conducting member, should not openly flame during use of the smoking article, should have controllable smolder properties, and should produce a gray ash. Exemplary, cigarette papers of this type are described in U.S. Pat. No. 4,779,631 to Durocher et al. and European Patent Publication No. 304,766. Suitable paper wrappers are available as P-1981-152, P-1981-124 and P-1224-63 from Kimberly-Clark Corp. Suitable papers for the FIGS. 2 and 3 type cigarettes include Kimberly-Clark's P-2831-189-AA and P-3122-153. Tipping paper can circumscribe the extreme mouth end of the smoking article. Suitable tipping papers are non-porous tipping papers treated with "non-lipsticking" materials, and such papers will be apparent to the skilled artisan.

The present invention will be further illustrated with reference to the following examples which aid in the understanding of the present invention, but which are not to be construed as limitations thereof. All percentages reported herein, unless otherwise specified, are percent by weight. All temperatures are expressed in degrees Celsius.

EXAMPLE 1

GENERAL TECHNIQUES

The stabilized substrate compositions of the present invention are prepared by the following general techniques.

The binder, e.g., ammonium alginate, is first admixed with an excess amount of water (e.g., about 70:1 (parts) water to binder, for approximately five minutes, to fully hydrate the same. Next, the aerosol forming material, or mixture of such materials, e.g., glycerin and optional flavorants, is added to the aqueous alginate slurry, and stirred to blend the same intimately. If ammonium alginate is employed as the binder, one or more sequestering agents, e.g., aqueous K_2CO_3, or the like, may be added to the slurry, if necessary or desired. Finally, dry ingredients, which may be first blended together (if desired) are added, e.g., precipitated $CaCO_3$ and/or tobacco. Stirring is continued to form an intimate admixture, in aqueous slurry form.

The final slurry may be further diluted with water to form a sprayable or printable mixture. Such mixtures are then applied to appropriate substrate base materials, e.g., tobacco cut filler, tobacco paper sheets, and the like. If desired, the undiluted slurry may be cast onto an appropriate surface, e.g., a high density polyethylene sheet, in strips of about 2 inches×3 inches (50.8 mm×76 mm) at at thickness ranging from about 0.010 to 0.080 inches (about 0.25 mm to 2.0 mm) and air dried. The resulting cast sheet may be shredded, e.g., at about 32 cuts per inch, and used as a substrate, e.g., in cut filler form, or blended with tobacco cut filler or other substrate materials to form a final substrate.

EXAMPLE 2

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	6.0 wt. percent
glycerin	45.0 wt. percent
K_2CO_3	1.0 wt. percent
$CaCO_3$	3.0 wt. percent
tobacco (American blend)	45.0 wt. percent

This slurry is cast at a thickness of about 0.04 inches (about 1 mm) onto a polyethylene sheet, air dried, and cut into strips resembling tobacco cut filler. The substrate material is overwrapped with a circumscribing paper wrapper and cut into segments having a diameter of 7.5 mm and a lengths of 10 or 15 mm, both useful as substrates.

EXAMPLE 3

A stabilized substrate composition is prepared in a two step method, by first spray applying 30.5 parts of a 1:1 water glycerin solution onto 69.5 parts reconstructed tobacco cut filler. The treated tobacco is then dried using a laboratory Master Heat Gun (Model No. HG-75/B from the Master Appliance Corp. of Racine, Wis.) at an air temperature of about 90° C. for sufficient time to provide a final moisture content of from about 12–15%.

Subsequently, a binder solution consisting of a 99:1 aqueous ammonium alginate (Kelco Co. Amoloid LV) is spray applied to the dried tobacco to yield a substrate product consisting of 1 part binder and 99 parts tobacco and glycerin (based on dry weight). This mixture is dried with the Master Heat Gun at an air temperature of about 90° C. to a produce a substrate composition having a final moisture content of from about 8–12%.

EXAMPLE 4

A stabilized substrate is prepared in a one step method by spray applying an aqueous mixture consisting of 30 parts glycerin and 1 part Amoloid LV ammonium alginate binder (with sufficient water to make a sprayable mixture) onto 69 parts American blend tobacco cut filler. The treated tobacco is then dried using a laboratory Master Heat Gun at an air temperature of about 90° C. for sufficient time to provide a substrate composition having a final moisture content of from about 8–12%.

EXAMPLE 5

A. The two-step procedure of Example 3 is repeated, using volume expanded tobacco as the substrate base material, to form a substrate composition consisting of 30 parts glycerin, 1 part Amoloid LV binder and 69 parts tobacco.

B. The one-step procedure of Example 4 is repeated, using volume expanded tobacco as the substrate base material, to form a substrate composition consisting of 30 parts glycerin, 1 part Amoloid LV binder and 69 parts tobacco.

EXAMPLE 6

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	11 wt. percent
glycerin	89 wt. percent

This slurry is printed onto a sheet of Kimberly-Clark's P3122-109-A16 tobacco paper to a final loading

ammonium alginate Kelco HV	13.5 parts by wt.
glycerin	81.0 parts by wt.
PCB-G carbon with 30% menthol	5.5 parts by wt.

The carbon/menthol mixture is prepared by ball milling PCB-G activated carbon from Calgon Carbon Corp., Pittsburgh, Pa., with 30 wt. percent solid menthol. During the ball milling process the mixture becomes warm, which causes the menthol to vaporize, and the activated carbon adsorbs and/or absorbs the menthol vapors.

The slurry is cast at a thickness of about 0.04 inch (about 1 mm) onto Kimberly Clark's No. P-3122-109-A16 paper and air dried under ambient conditions to drive off excess moisture. This substrate composition can be shredded into cut filler or made into a gathered web. This composition as cut filler or gathered web can be made into 7.5 mm diameter paper wrapped rods and cut into 10 mm sections to be used as substrates.

EXAMPLE 15

An aqueous slurry based on a ratio of 4 parts water to one part solids is prepared in the following manner:

Water at 180° F. (about 82° C.) is added to a high sheer mixer. Tobacco solids at 61.3 weight percent (containing 10% moisture) are added to the water and thoroughly mixed therewith. Next, 3.8 weight percent dibasic diammonium phosphate is added to the mixture, which is stirred (digested) for 30–45 minutes. Then, 4.2 weight percent of a 30% aqueous ammonium hydroxide solution is added and mixed (digested) for another 30–45 minutes. Finally, 30.7 weight percent glycerin is added and the mixture is stirred an additional 10–15 minutes.

The resulting slurry is cast on a stainless steel belt at a thickness of 0.03 inches (about 0.76 mm) to form a sheet. Air at 200° F. (about 93° C.) is blown over the upper surface of the sheet while steam contacts the underside of the stainless steel belt. The combined heating methods dry the sheet without driving off the aerosol forming materials. The sheet is doctored off the belt. The film may be shredded into cut filler or made into a gathered web, then overwrapped with paper and cut into 7.5 mm diameter by 10–15 mm long substrate sections.

EXAMPLE 16

Example 15 is repeated, with the following ingredients:

glycerin	47 weight percent
tobacco solids	47 weight percent
diammonium phosphate dibasic	3 weight percent
30% ammonium hydroxide	3 weight percent

EXAMPLE 17

An aqueous slurry based on a ratio of 4 parts water to one part solids is prepared in the following manner:

Water heated to about 180° F. (about 82° C.) is added to a high sheer mixer. Tobacco solids at 32 weight percent (containing 10% moisture) is added to the water and thoroughly mixed therewith. Next, 2 weight percent dibasic diammonium phosphate is added to the mixture, which is stirred for 30–45 minutes. Then, 2 weight percent of a 30% aqueous ammonium hydroxide solution is added and mixed for 30–45 minutes.

Ammonium alginate (Kelco HV) at 4 weight percent is activated in 180° F. (about 82° C.) water at a 1:15 solids to water ratio.

Glycerin at 60 weight percent is added to the tobacco slurry, followed by the activated ammonium alginate. This mixture is stirred at high shear for 10–15 minutes.

This slurry is cast on a stainless steel belt at a thickness of 0.03 inches (about 0.76 mm) to form a sheet. Air at 200° F. (about 93° C.) is blown over the upper surface of the sheet while steam contacts the underside of the stainless steel belt. The combined heating methods dry the sheet without driving off the aerosol forming materials. The sheet is doctored off the belt. The film may be shredded into cut filler or made into a gathered web, then overwrapped with paper and cut into 7.5 mm diameter by 10–15 mm long substrate sections.

EXAMPLE 17

Example 16 is repeated, with the following ingredients:

glycerin	60 weight percent
tobacco solids	30 weight percent
diammonium phosphate dibasic	2 weight percent
30% ammonium hydroxide	2 weight percent
Kelco HV	6 weight percent

EXAMPLE 18

CIGARETTE OF FIG. 1

Fuel Element Preparation

A generally cylindrical fuel element 9 mm long and 4.5 mm in diameter, and having an apparent (bulk) density of about 1.02 g/cc is prepared from about 72 parts hardwood pulp carbon having an average particle size of 12 microns in diameter, about 20 parts of blended tobacco dust including Burley, flue cured and oriental, the dust being approximately 200 Tyler mesh, and 8 parts Hercules 7HF SCMC binder.

The hardwood pulp carbon is prepared by carbonizing a non-talc containing grade of Grande Prairie Canadian kraft hardwood paper under nitrogen blanket, increasing the temperature in a step-wise manner sufficient to minimize oxidation of the paper, to a final carbonizing temperature of at least 750° C. The resulting carbon material is cooled under nitrogen to less than 35° C., and then ground to fine power having an average particle size of about 12 microns in diameter.

The finely powdered hardwood carbon is admixed with the tobacco dust, the sodium carboxymethyl cellulose binder, and sufficient water to provide a mixture having a stiff, dough-like paste form.

Fuel elements are extruded using a ram extruder from the paste so as to have 5 equally spaced peripheral slots or grooves, each having a depth of about 0.032 inch and a width of about 0.016 inch. The configuration of the passageways which extend longitudinally through the fuel element is shown in FIG. 1A. The resulting extrudate is dried in air to provide a resilient extrudate, and the extrudate is cut into 9 mm lengths, thereby providing fuel elements.

cient to minimize oxidation of the paper, to a final carbonizing temperature of at least 750° C. The resulting carbon material is cooled under nitrogen to less than 35° C., and then ground to fine power having an average particle size of about 12 microns in diameter.

The finely powdered hardwood carbon is dry mixed with the alginate binder, and then an 3% percent aqueous solution of sodium carbonate is added to provide an extrudable mixture, having a final Na_2CO_3 content of 0.9 parts by weight.

Cylindrical fuel rods (each about 24 inches long) are extruded using a screw extruder from the mixture having a generally cylindrical shape about 4.8 mm in diameter, with six (6) equally spaced peripheral grooves (about 1 mm × 1 mm) with rounded bottoms, running from end to end. The extruded rods have an initial moisture level ranging from about 32–34 weight percent. They are dried at ambient temperature for about 16 hours and the final moisture content is about 7–8 weight percent.

The dried cylindrical rods are end trimmed to a length of 22.5 inches using diamond tipped steel cutting wheels. The rods are placed into a rotating drum having a plurality of channels adapted for accepting and retaining each fuel rod. The rods are secured into the channels on the drum by a plurality of thin rubber straps. The drum is rotated past a shaft having a series of spaced, thin, circular, diamond tipped steel blades. Exemplary blades are the 4-inch diameter 100 to 120 grit blades available from the Norton Co. as 1AIR. The blades are positioned on a shaft so as to create the isolation segments along the length of each rod and trim the rod to the correct length for the next operation. The dimensions of the isolation segments are provided by movement of the shaft or by the use of a wobble plate. The drum continues to rotate and the rod is released therefrom.

The cut rod is then placed into another rotating drum having a plurality of channels adapted for accepting and retaining the rod. The rods are secured in the channels on the drum by a plurality of thin rubber straps. The drum is rotated past a shaft having a series of spaced diamond tipped blades positioned to cut through the rod in the desired locations, forming individual fuel elements. The drum continues to rotate to release the cut fuel elements therefrom into a collection bin.

The finished fuel elements are each 12 mm in length, having end segment lengths of 2.5 mm, two isolation segments 1.5 mm in length each, and an intermediate segment 4.0 mm in length. As such, the cross-sectional area of the isolation segments is about 49% of the cross-sectional area of the end segments. Each fuel element weighs about 165 mg.

Front End Preparation

The fuel element is circumscribed by Owens-Corning C-glass fibers. For details regarding the properties of this material see pages 48–52 of the RJR Monograph, supra. The glass fibers are in turn circumscribed by a paper wrapper available from Kimberly-Clark Corp. as P-2831-189-AA, providing a cylinder having open ends for the passage of air therethrough, a length of about 16 mm and a circumference of about 7.5 mm.

Substrate

Any of the substrates identified in Examples 1–13 may be successfully employed herein. One especially preferred substrate is set forth in Example 9.

Mouthend Piece

A paper tube of about 63 mm length and about 7.5 mm diameter is made from a web of paper about 27 mm wide. The paper is a 76 lb. basis weight paper having a thickness of about 0.012 inch, which is available from Simpson Paper Co. as RJR-001. The paper is formed into a tube by lap-joining the paper using a water-based ethylene vinyl acetate adhesive. To prevent any possible aerosol former migration, the inner surface of the tube is coated with Hercon 70 from Hercules, Inc. about 10 mm into the tube and allowed to dry. Then, the once coated inner surface of the tube is again coated, but with an aqueous solution of calcium chloride (to prevent burning), and allowed to dry.

A 10 mm long substrate is inserted into the coated end of the paper tube such that the front face of the substrate is about 3 mm from the front end of the paper tube. The substrate is held in place securely within the paper tube by friction fit. A 10 mm long segment of tobacco cut filler, wrapped in a circumscribing paper wrapper is inserted into the opposite end of the tube. This tobacco segment is pushed into the tube so that the back end of the tobacco is about 10 mm from the extreme mouth end of the tube.

Into the end of the paper tube opposite the substrate is inserted a cylindrical filter element so as to abut the segment of tobacco cut filler. The filter element has a length of about 10 mm and a circumference of about 24 mm. The filter element is provided using known filter making techniques from triacetin plasticized cellulose acetate tow (8.0 denier per filament; 40,000 total denier), and circumscribing paper plug wrap.

Assembly of the Cigarette

The mouthend piece and front end are positioned in an abutting, end-to-end relationship, such that the front face of the substrate is positioned about 3 mm from the back face of the fuel element. The front end and mouthend pieces are held together by a circumscribing paper wrapper which acts as a tipping paper. The paper wrapper is a low porosity paper available as P-850-61-2 from Kimberly-Clark Corp., and circumscribes the entire length of the front end piece except for about a 3 mm length of the front end piece at the extreme lighting end thereof.

The cigarette is smoked, and yields visible aerosol and tobacco flavor (i.e., volatilized tobacco components) on all puffs for about 10–12 puffs. The fuel element burns to about the region thereof where the burning portion meets the isolation portion, and the cigarette self-extinguishes.

EXAMPLE 20

Fuel Element Preparation

A fuel element 12 mm long and 4.8 mm in diameter, and having an apparent (bulk) density of about 1.02 g/cc is prepared from about 78.7 parts hardwood pulp carbon having an average particle size of 12 microns in diameter, 10 parts ammonium alginate (Amoloid HV, Kelco Co.), 1.0 parts Na_2CO_3, 10 parts, ball-milled American blend tobacco and 0.3 parts tobacco extract, obtained as described in U.S. patent application Ser. No. 07/710,273, filed Jun. 9, 1991.

The hardwood pulp carbon is prepared by carbonizing a non-talc containing grade of Grande Prairie Canadian kraft hardwood paper under nitrogen blanket,

8. The stabilized aerosol forming composition of claim 1, further comprising a base material to which the stabilized composition has been applied, said base material being selected from the group of organic-based and inorganic-based, mat, web, sheet, shredded, or cut filler materials.

9. The stabilized aerosol forming composition of claim 8, wherein the base material is an inorganic-base material selected from the group of aluminum foil, plastic film, or glass fiber mat.

10. The stabilized aerosol forming composition of claim 8, wherein the base material is an organic-based paper material, in a sheet, mat, web, shredded, or cut filler form.

11. A cigarette comprising:

(a) a fuel element less than about 30 mm in length prior to smoking;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising tobacco, binder and an aerosol forming material, wherein the aerosol forming material is present in an amount of at least about 40% by weight of the substrate;

(c) a tobacco segment, comprising tobacco cut filler, separate from said substrate; and

(d) a mouthend piece.

12. The cigarette of claim 11, wherein the substrate further comprises an inorganic filler material.

13. The cigarette of claim 12, wherein the inorganic filler material comprises calcium carbonate.

14. The cigarette of claim 11, wherein the aerosol forming material comprises glycerine.

15. The cigarette of claim 11, wherein the binder comprises ammonium alginate.

16. The cigarette of claim 11, wherein the substrate further comprises tobacco extract.

17. The cigarette of claim 11, wherein the tobacco comprises tobacco powder.

18. The cigarette of claim 11, wherein the tobacco comprises tobacco powder, the binder comprises ammonium alginate and the aerosol forming material comprises glycerine.

19. The cigarette of claim 11, wherein the tobacco segment comprises reconstituted tobacco.

20. The cigarette of claim 11, wherein the tobacco segment is disposed longitudinally behind the substrate.

21. The cigarette of claim 11, wherein the fuel element comprises a carbonaceous material.

22. A cigarette comprising:

(a) a fuel element less than about 30 mm in length prior to smoking;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising cast sheets of cut filler formed from a mixture comprising tobacco, binder and a polyhydric alcohol aerosol forming material, wherein the aerosol forming material is present in an amount of at least about 40% by weight of the substrate;

(c) a tobacco segment, comprising tobacco cut filler, separate from said substrate; and

(d) a mouthend piece.

23. The cigarette of claim 22, wherein the substrate further comprises an inorganic filler material.

24. The cigarette of claim 23, wherein the inorganic filler material comprises calcium carbonate.

25. The cigarette of claim 22, wherein the aerosol forming material comprises glycerine.

26. The cigarette of claim 22, wherein the binder comprises ammonium alginate.

27. The cigarette of claim 13, wherein the substrate further comprises tobacco extract.

28. The cigarette of claim 13, wherein the tobacco comprises tobacco powder.

29. The cigarette of claim 22, wherein the tobacco comprises tobacco powder, the binder comprises ammonium alginate and the aerosol forming material comprises glycerine.

30. The cigarette of claim 22, wherein the tobacco segment comprises reconstituted tobacco.

31. The cigarette of claim 22, wherein the tobacco segment is disposed longitudinally behind the substrate.

32. The cigarette of claim 22, wherein the fuel element comprises a carbonaceous material.

33. A cigarette comprising:

(a) a fuel element less than about 30 mm in length prior to smoking;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising tobacco, binder and an aerosol forming material, wherein the aerosol forming material is present in an amount of at least about 40% by weight of the substrate, and wherein the ratio of aerosol forming material to binder is in the range of from 3:1 to 40:1;

(c) a tobacco segment, comprising tobacco cut filler, separate from said substrate; and

(d) a mouthend piece.

34. The cigarette of claim 33, wherein the substrate further comprises an inorganic filler material.

35. The cigarette of claim 34, wherein the inorganic filler material comprises calcium carbonate.

36. The cigarette of claim 33, wherein the aerosol forming material comprises glycerine.

37. The cigarette of claim 33, wherein the binder comprises ammonium alginate.

38. The cigarette of claim 33, wherein the substrate further comprises tobacco extract.

39. The cigarette of claim 33, wherein the tobacco comprises tobacco powder.

40. The cigarette of claim 33, wherein the tobacco comprises tobacco powder, the binder comprises ammonium alginate and the aerosol forming material comprises glycerine.

41. The cigarette of claim 33, wherein the tobacco segment comprises reconstituted tobacco.

42. The cigarette of claim 33, wherein the tobacco segment is disposed longitudinally behind the substrate.

43. The cigarette of claim 33, wherein the fuel element comprises a carbonaceous material.

44. A cigarette comprising:

(a) a fuel element less than about 30 mm in length prior to smoking;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising cast sheets of cut filler formed from a mixture comprising tobacco, binder and a polyhydric alcohol aerosol forming material, wherein the aerosol forming material is present in an amount of at least about 40% by weight of the substrate, and wherein the ratio of aerosol forming material to binder is in the range of from 3:1 to 40:1;

(c) a tobacco segment, comprising tobacco cut filler, separate from said substrate; and

(d) a mouthend piece.

45. The cigarette of claim 44, wherein the substrate further comprises an inorganic filler material.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,415,186
DATED : May 16, 1995
INVENTOR(S) : William J. Casey, III et al.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Col. 1, line 47 - "clearman" -- change to -- Clearman --.

Col. 15, line 25 - "glyserin" - change to -- glycerin --.

Col. 18, line 60 - after "5,105,838" insert -- to White et al.--.

Col. 18, line 67 - delete "and No. 07/601,551, filed,"

Col. 18, line 68 - delete "Oct. 23, 1990."

Col. 19, line 42 - after 5,105,837 - add "to Barnes et al."

Col. 34, line 3 - claim "13" should be claim -- 22 --.

Col. 34, line 5 - claim "13" should be claim -- 22 --.

Signed and Sealed this

Third Day of September, 1996

Attest: Bruce Lehman

Attesting Officer

BRUCE LEHMAN

Commissioner of Patents and Trademarks

51696 0933

PROJECT ALPHA

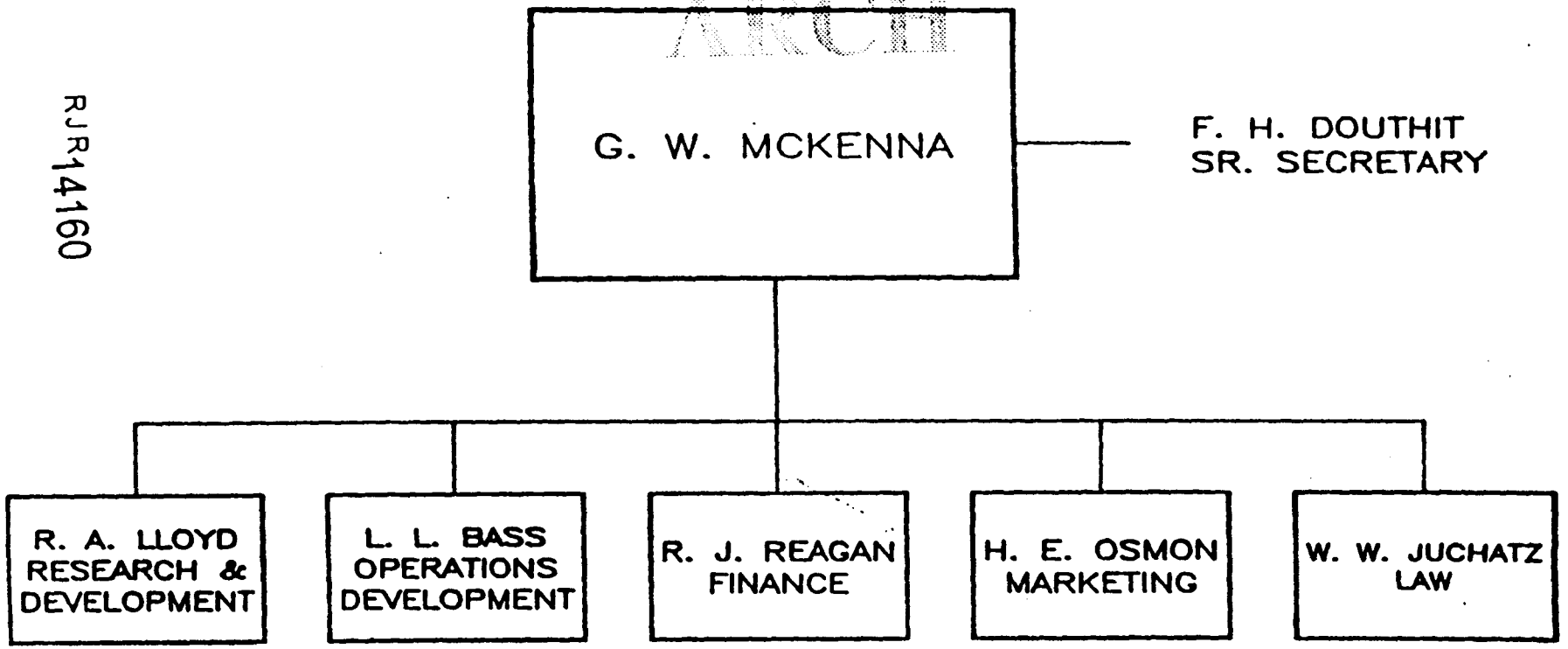
ORGANIZATIONAL

STRUCTURE

RJR 14159

PROJECT ALPHA

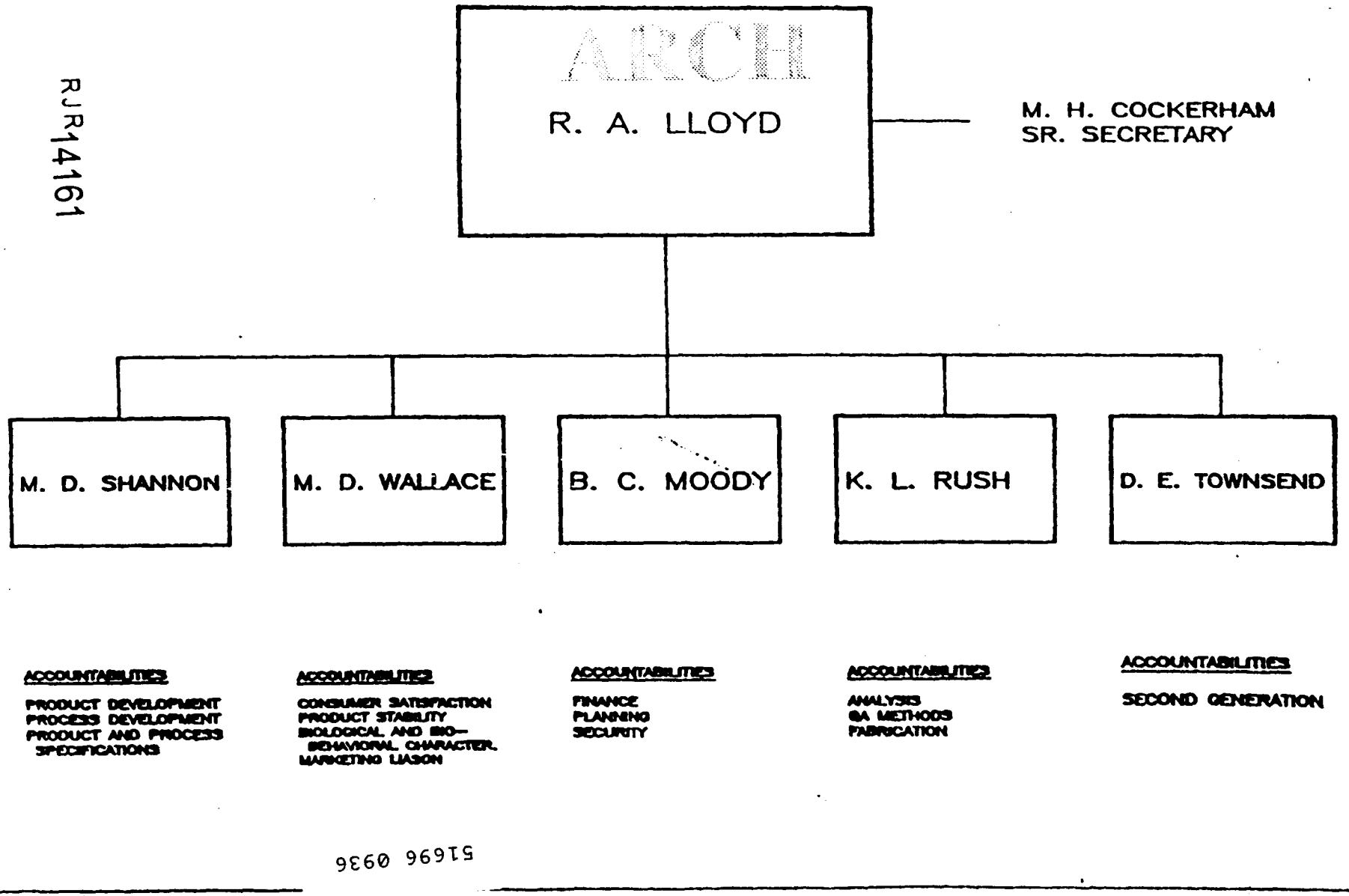
RJR14160



51696 0935

RESEARCH AND DEVELOPMENT
PROJECT ALPHA

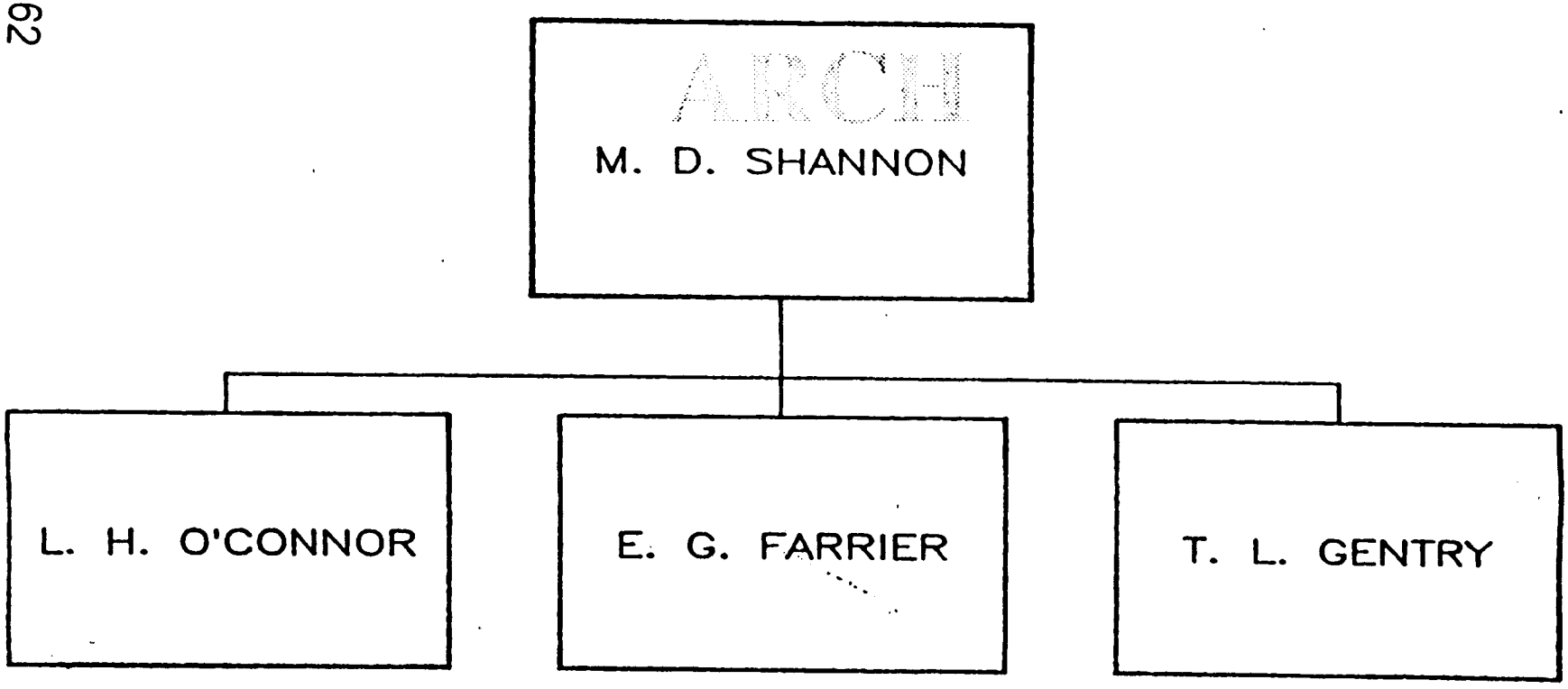
RJR14161



51696 0936

RJR14162

PRODUCT DEVELOPMENT



ACCOUNTABILITIES

SYSTEM PERFORMANCE
- INTERIM SPECS
- DESIGN IMPROVEMENTS
- OPTIMIZATION
- FINAL SPECIFICATIONS

COMPONENT DEVELOPMENT
COST REDUCTION

ACCOUNTABILITIES

FUEL SOURCE
- TASTE/AROMA PROBLEM
- INTERIM PROCESS

CAPSULE
- IDENTIFY SUPPLIERS
- DETERMINE SPECS
- RECOMMEND OPTIONS

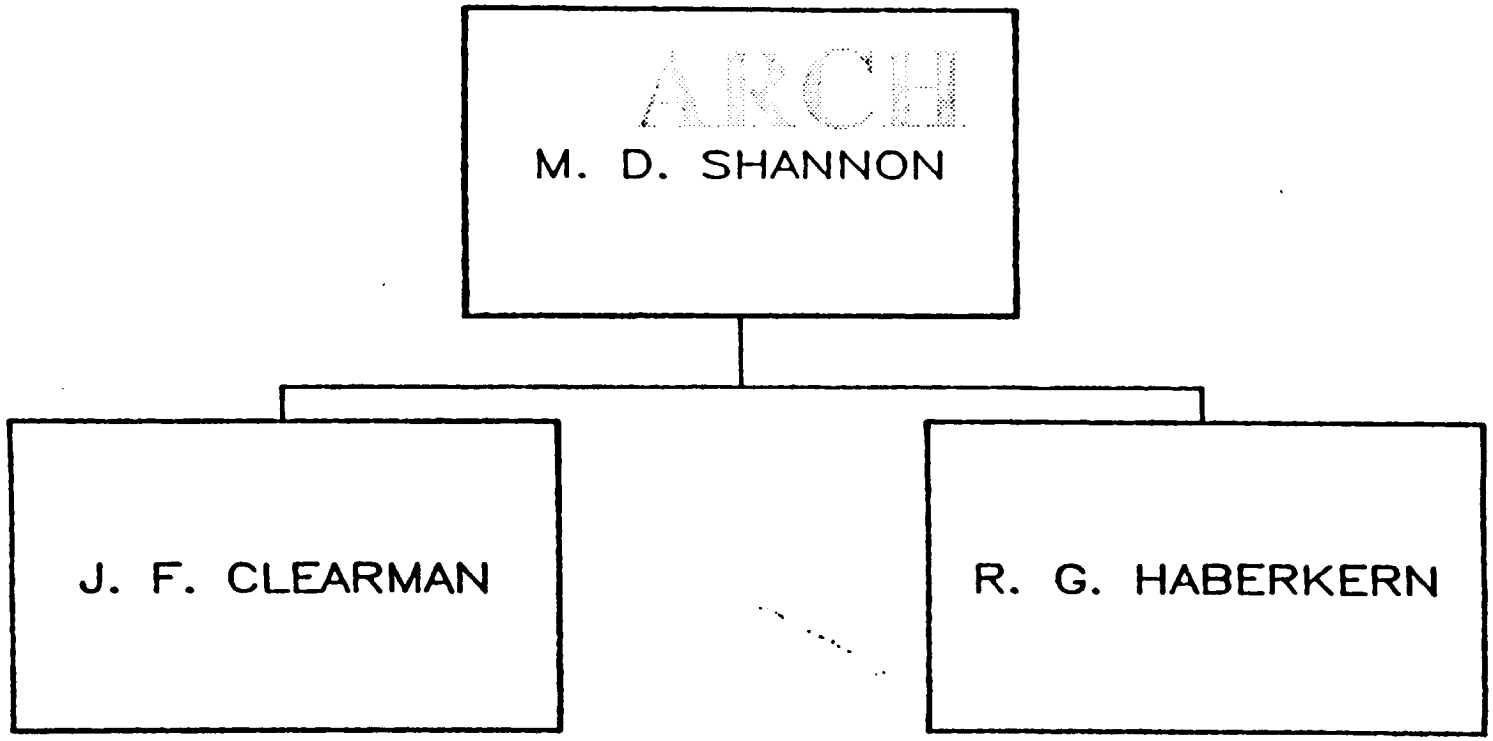
TROUBLE SHOOTING

ACCOUNTABILITIES

FLAVOR
- STRENGTH
- TOBACCO

TROUBLE SHOOTING

PRODUCT DEVELOPMENT



ACCOUNTABILITIES

FUEL SOURCE
OPTIMIZATION

ACCOUNTABILITIES

SUBSTRATE MATERIALS
- SINTERING/LOADING

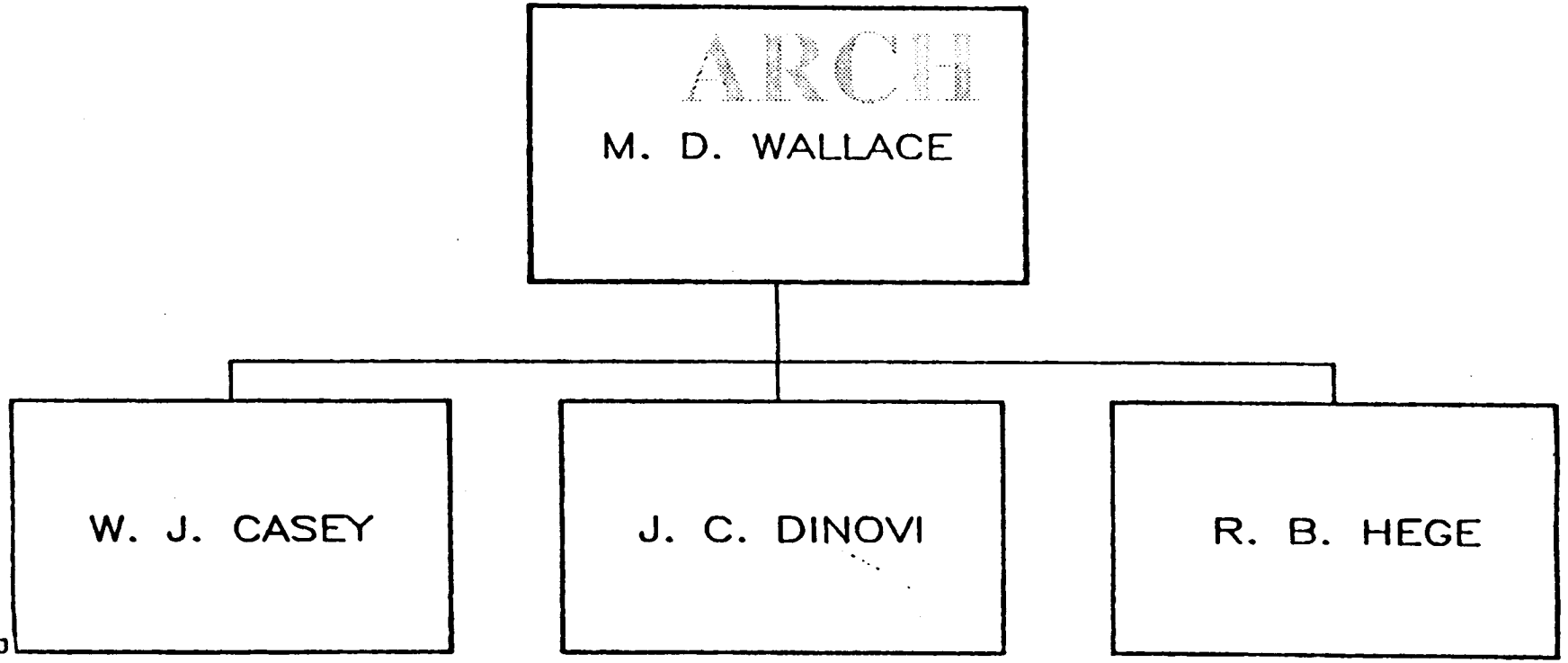
TOBACCO EXTRACTS
- SPRAY DRIED/NICOTINE

FUEL SOURCE
- VENDOR LIASON

RJR14163

51696 0938

PRODUCT APPLICATIONS



RJR14164

ACCOUNTABILITIES

O. D. COORDINATION
- TOXICOLOGY STUDIES

TOBACCO RESEARCH
- NEW DESIGNS
- ANALYTICALS

ACCOUNTABILITIES

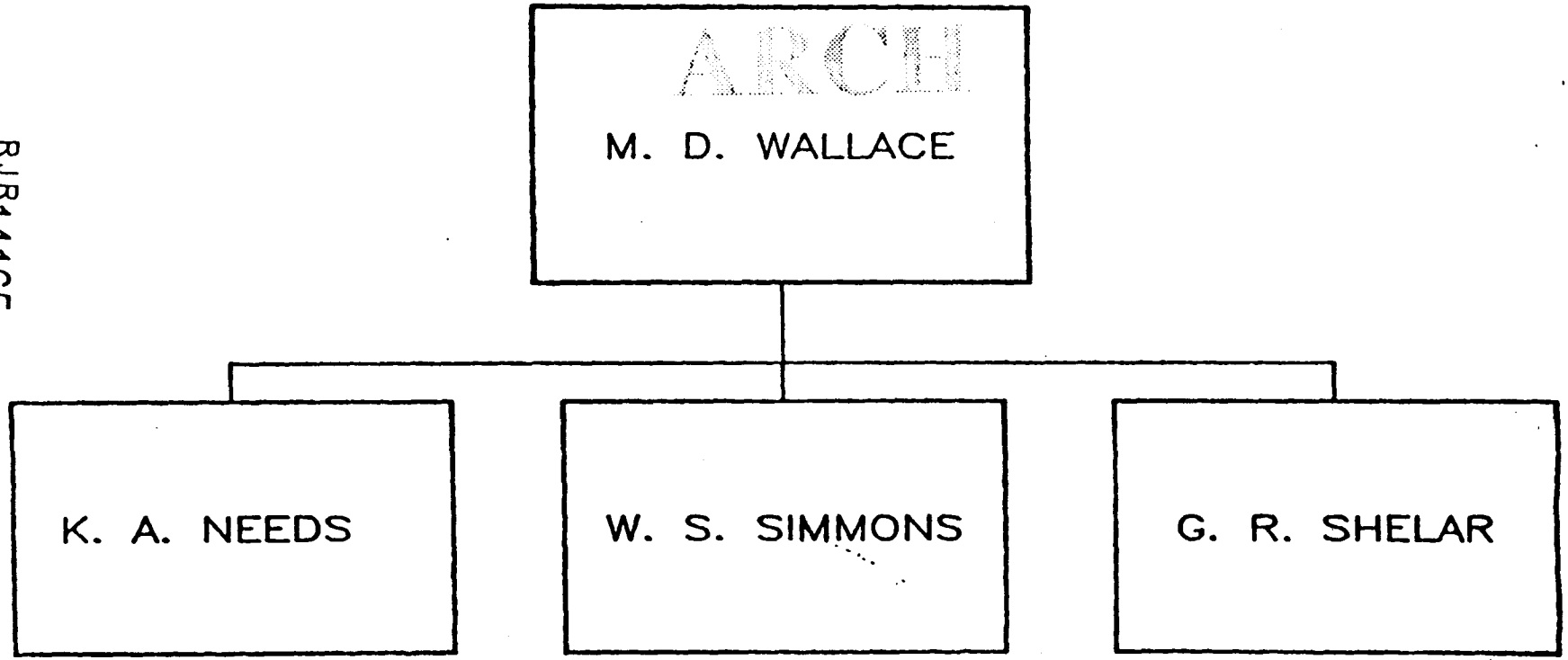
FLAVOR DEVELOPMENT
- MANAGE PERSONNEL
- DIRECT ACTIVITIES OF OUTSIDE CONTRACTORS
- EMPIRICAL RESEARCH

ACCOUNTABILITIES

PRODUCT STABILITY STUDIES
SHELF LIFE STUDIES
DETERMINATION OF PRODUCT PROTECTION REQUIREMENTS

PRODUCT APPLICATIONS

in



ACCOUNTABILITIES

IN-HOUSE SENSORY TESTING
COORDINATE CONSUMER TESTING

ACCOUNTABILITIES

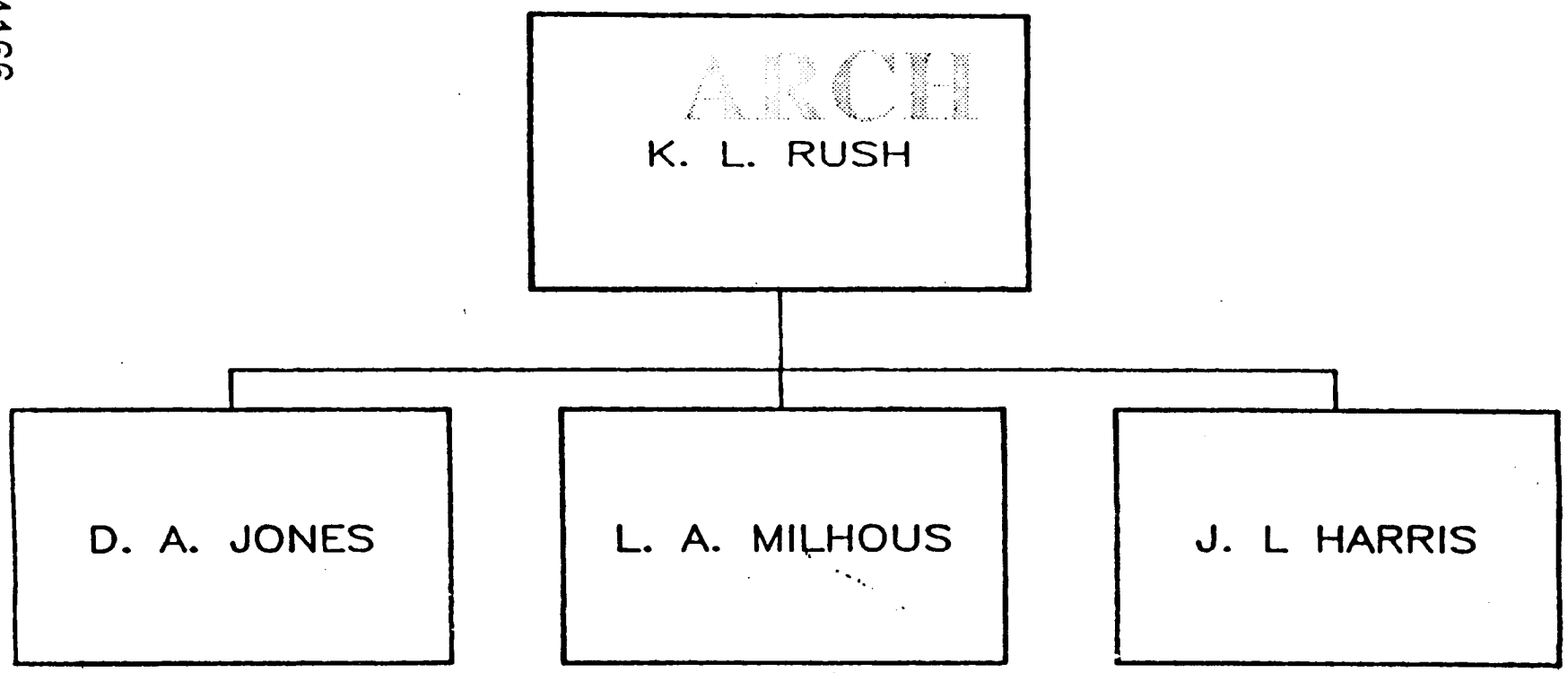
TOXICOLOGICAL STUDIES COORDINATION

ACCOUNTABILITIES

TOBACCO RESEARCH
- MODEL DEVELOPMENT
- TASTE/SATISFACTION
- NEW DESIGNS
- LIASON TO PRODUCT DEVELOPMENT GROUP

ANALYTICAL METHODS

RJR 14166



ACCOUNTABILITIES

FABRICATION
- INVENTORY CONTROL
- PRODUCTION SCHEDULING
- CUSTOM PRODUCTION
- QUALITY ASSURANCE

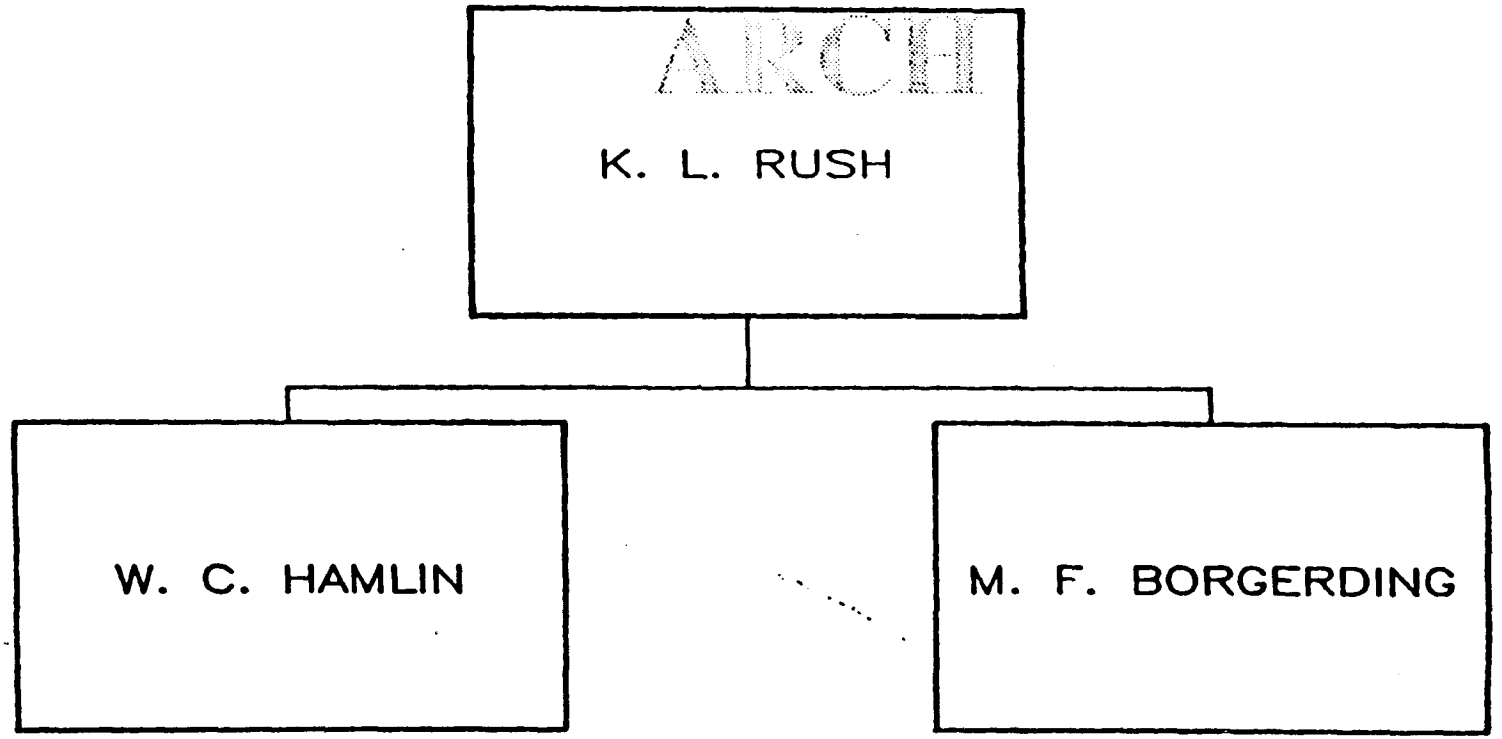
ACCOUNTABILITIES

CHEMICAL LABORATORY
- EXPERIMENT DESIGN
- ANALYTICAL RESEARCH
- DATA INTERPRETATION
- QA METHODOLOGY
- RECORDS MAINTENANCE

ACCOUNTABILITIES

THERMAL LABORATORY
- HEAT FLOW ANALYSIS
- NEW TECHNIQUE DEVELOPMENT
- DATA INTERPRETATION
- INSTRUMENTATION SPECIFICATION

ANALYTICAL METHODS



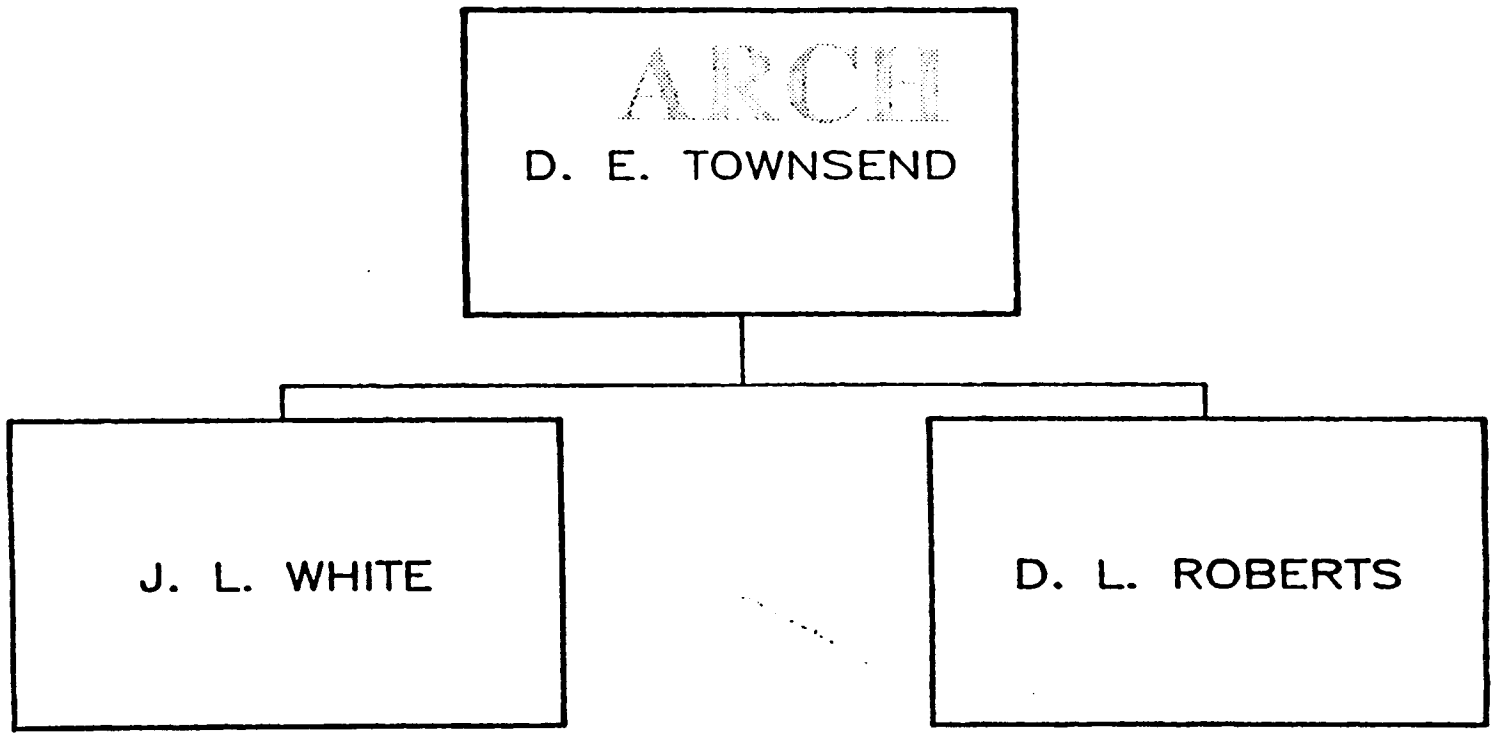
ACCOUNTABILITIES

PHYSICAL LABORATORY
- EXPERIMENT DESIGN
- ANALYTICAL RESEARCH
- DATA INTERPRETATION
- QA METHODOLOGY
- RECORDS MAINTENANCE

ACCOUNTABILITIES

METHODS DEVELOPMENT
- METHODS VALIDATION
- SPECIAL ANALYTICAL STUDIES
- NEW METHODS DEVELOPMENT
- INSTRUMENTATION SPECIFICATION AND ACQUISITION

SECOND GENERATION



ACCOUNTABILITIES

SHORT DEVELOPMENT TIME
- WHITE'S DESIGN
- ALTERNATE INSULATOR

ACCOUNTABILITIES

LONGER DEVELOPMENT TIME
- COMBUSTION SYSTEM
- NON-COMBUSTION SYSTEM

RJR14168

OPERATIONS DEVELOPMENT
PROJECT ALPHA

RJR14169

L. L. BASS

J. S. BURGESS
SR. SECRETARY

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B. L. HESTER

M. N. BAKER

ACCOUNTABILITIES

PLANNING
COORDINATION
SCHEDULING
R & D LIASON

ACCOUNTABILITIES

INSTRUMENTATION AND
CONTROL
FUEL SOURCE PRODUCTION

ACCOUNTABILITIES

MECHANICAL DESIGN
- BENCH SCALE EQUIPMENT
- GLASS FIBER MACHINERY
- CAPSULE MACHINERY
- PACKERS

MACHINERY DEVELOPMENT
- PRODUCTION CONCEPTS
- VENDOR LIASON

51696 0944

OPERATIONS DEVELOPMENT
PROJECT ALPHA

RJR14170

L. L. BASS

J. L. COTHREN

J. G. CONRAD

L. W. PETERSON

ACCOUNTABILITIES

START UP PHASE:
- STAFFING/TRAINING
- INITIAL PRODUCTION
- INVENTORY CONTROL
- PRODUCTION PLANNING
- PRODUCTION WASTE

ACCOUNTABILITIES

FINANCIAL SUPPORT
- BUDGETING
- COST ESTIMATING
- AR/CA

PERSONNEL SUPPORT
SECURITY
OFFICE SERVICES
PLANNING

ACCOUNTABILITIES

DEVELOP QA PROGRAM
PRODUCT SPECIFICATIONS/
R & D INTERFACE
QA STAFFING/TRAINING
QA EQUIPMENT/
FACILITIES PLANNING

51696 0945

OPERATIONS DEVELOPMENT
PROJECT ALPHA

L. L. BASS

D. G. HUBBARD

D. H. BEESON

R. C. JOHNSON

ACCOUNTABILITIES

FACILITIES COORDINATION
- DIRECT ENGINEERING, DESIGN, CONSTRUCTION
- SPACE PLANNING
- MACHINERY LAYOUTS
- COST ESTIMATING
- PRODUCTION REQUIREMENTS TRANSLATION

ACCOUNTABILITIES

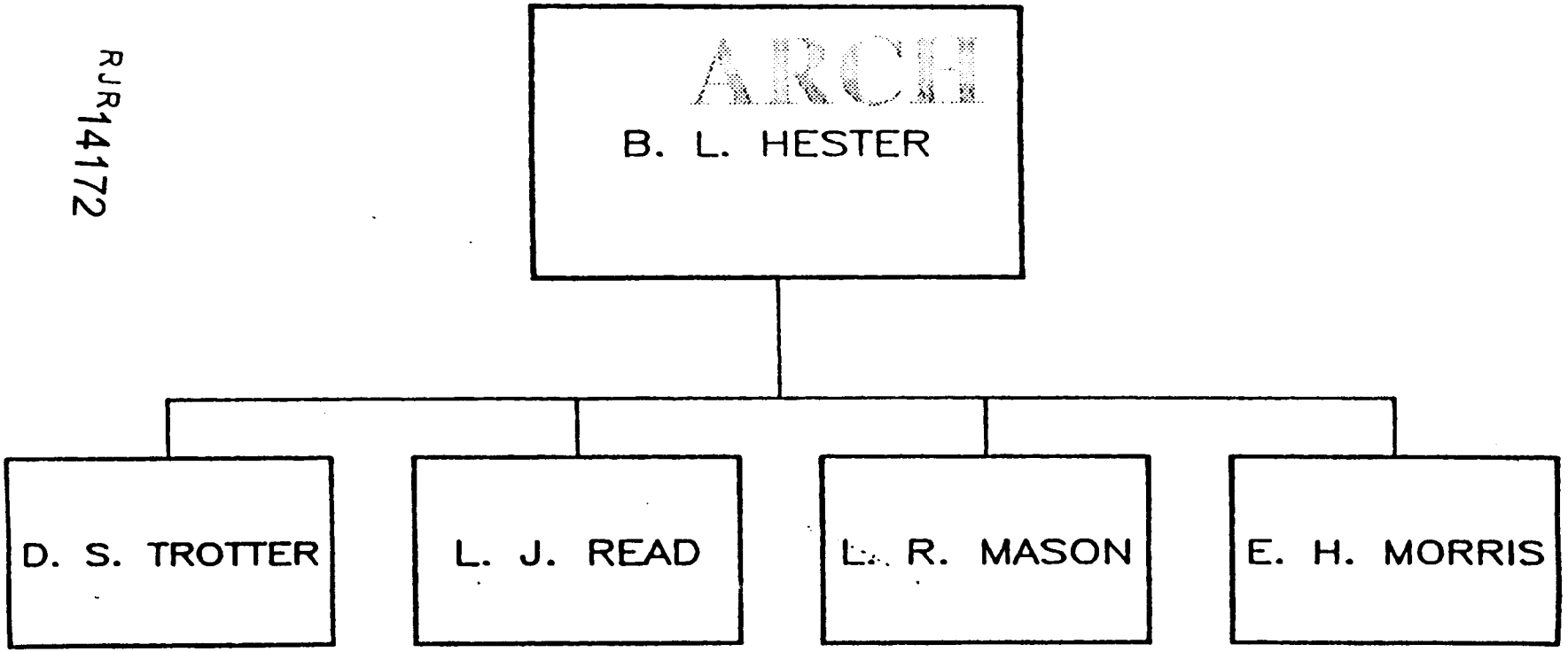
MACHINERY DELIVERY/ INSTALLATION SCHEDULING
MACHINERY START-UP
INSTALLATION COST ESTIMATING
COORDINATION

ACCOUNTABILITIES

SUPPORTING PROCESSES
- EXTRACTION/SPRAY DRYING
- SUBSTRATE SINTERING
- CAPSULE WASHING
- SUBSTRATE LOADING

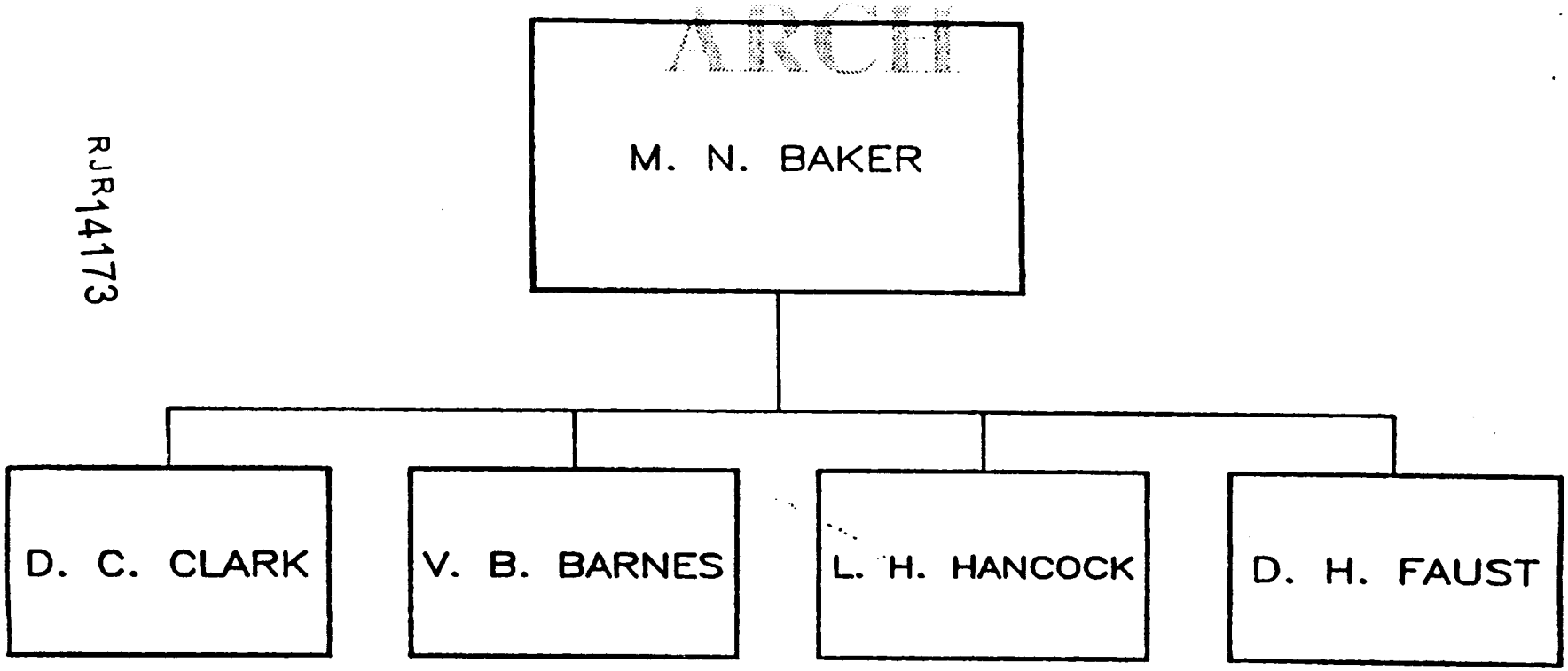
INSTRUMENTATION CONTROLS AND FUEL SOURCE PRODUCTION

RJR14172



MECHANICAL DESIGN

RJR14173



ACCOUNTABILITIES

BENCH SCALE EQUIPMENT
GLASS FILTER TUBE MACHINE

ACCOUNTABILITIES

CAPSULE MACHINERY
- IDENTIFY REQUIREMENTS
- VENDOR LIASON
- DEVELOP PRODUCTION CONCEPT

ACCOUNTABILITIES

GLASS FILTER TUBE MACHINERY
- IDENTIFY REQUIREMENTS
- VENDOR LIASON
- DEVELOP PRODUCTION CONCEPT

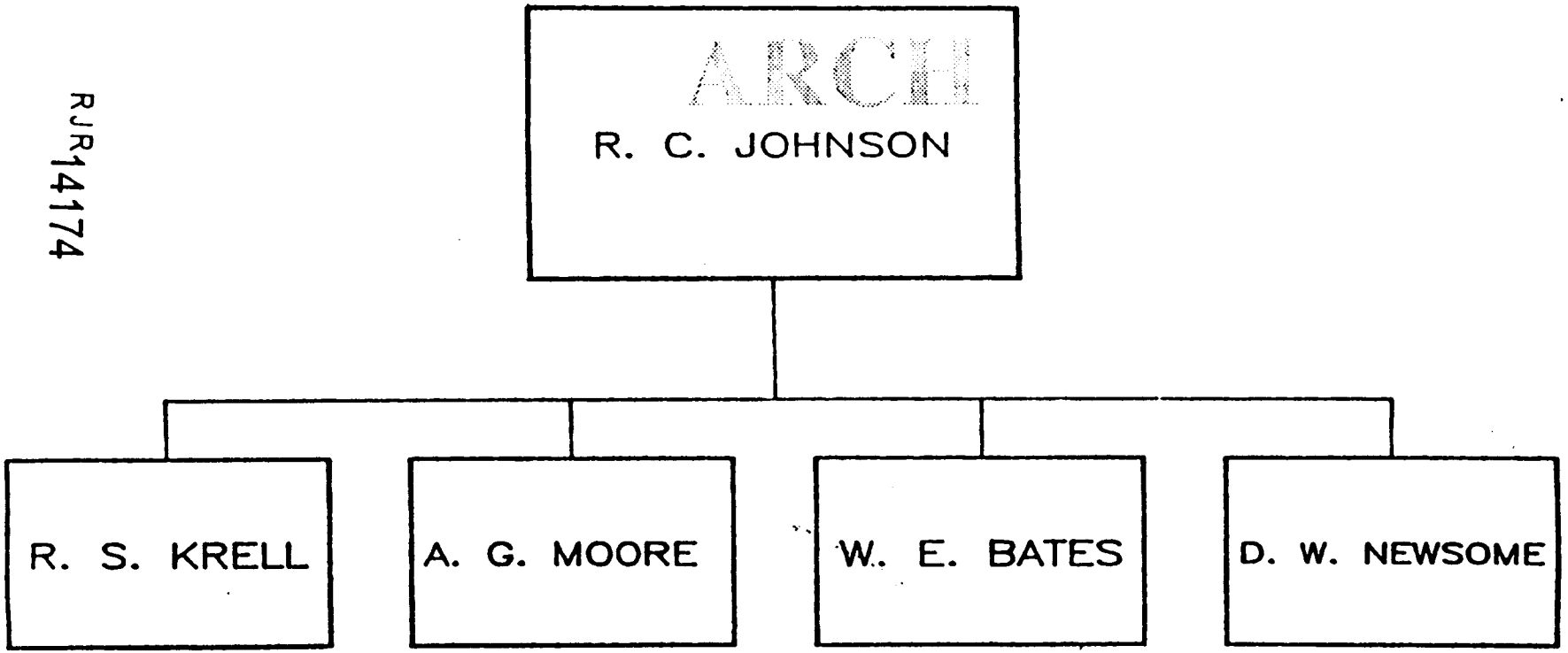
ACCOUNTABILITIES

PACKERS
- IDENTIFY REQUIREMENTS
- VENDOR LIASON
- DEVELOP PRODUCTION CONCEPT

SUPPORTING PROCESSES

in

RJR14174



51696 0949

FINANCE AND ADMINISTRATION
PROJECT ALPHA

R. J. REAGAN

L. W. ROSS
SECRETARY

S. N. WHITE

M. MOORE

R. S. BEATTY

ACCOUNTABILITIES

PROJECT ACCOUNTING
PROJECT REPORTING
AD AGENCY FINANCIAL CONTACT
AUTHORIZATIONS (AR/CA)
PLAN/BUDGET COORDINATION
ADMINISTRATIVE COORDINATION

ACCOUNTABILITIES

PRODUCT COSTING
FINANCIAL ANALYSIS
- CONTRACTS
- OVERALL PROJECT
- ROI
- SENSITIVITY ANALYSIS
- RISK ANALYSIS

PRODUCT PROFITABILITY

ACCOUNTABILITIES

ORDER OF MATERIALS
- FUEL SOURCE
- GLASS FIBER
- CAPSULE
- MOUTHPIECE
- SUPPORTING PROCESSES

PRODUCTION EQUIPMENT
FACILITIES NEEDS

MARKETING
PROJECT ALPHA

H. E. OSMON

P. W. HOOTS
SR. SECRETARY

E. J. FACKLEMAN

J. G. TOBIN

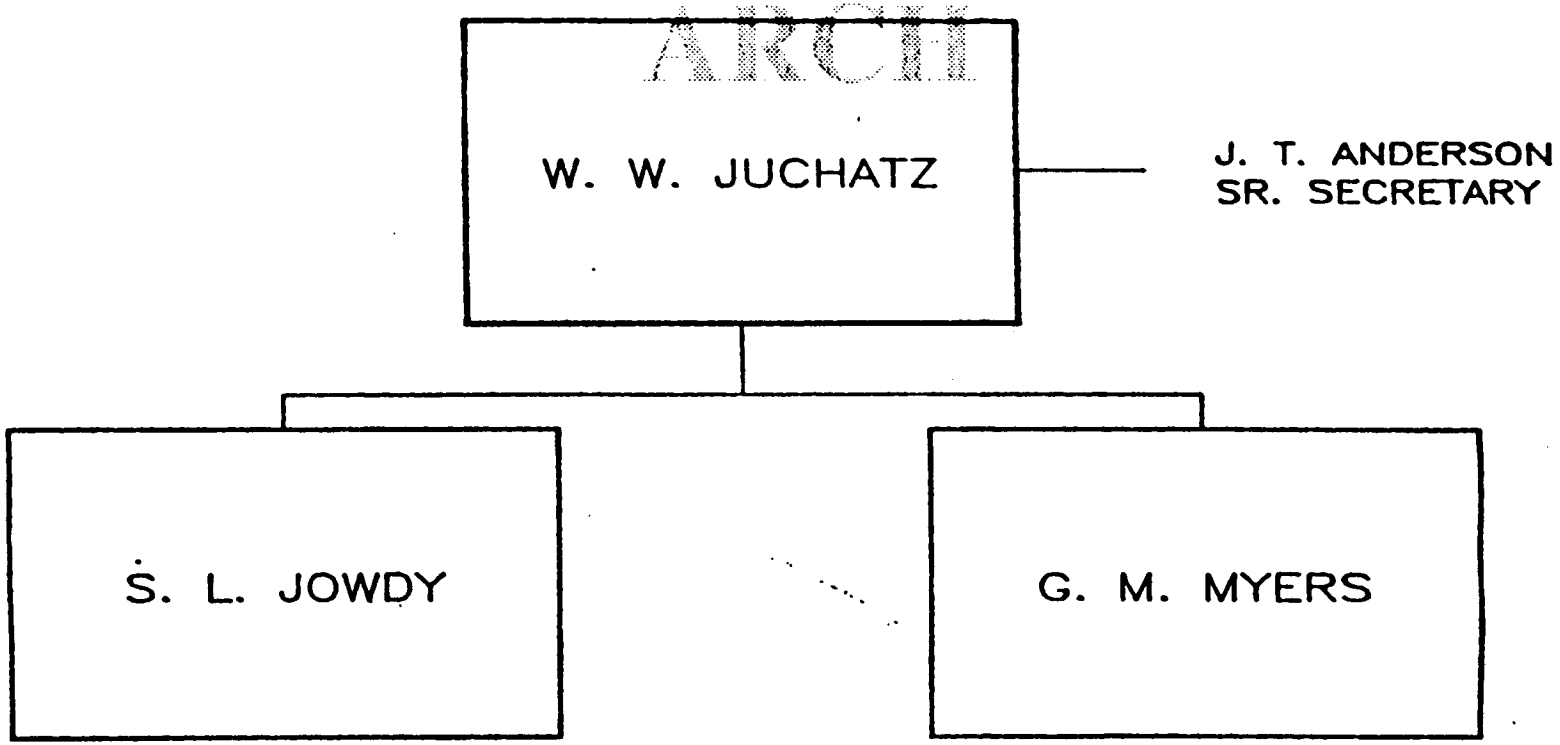
ACCOUNTABILITIES

PRODUCT TESTING
NAME TESTING
PACKAGE TESTING
ADVERTISING EVALUATION
PRICE RESEARCH

ACCOUNTABILITIES

ADVERTISING COPY/CAMPAIGN
NAME SELECTION
PACKAGE DESIGN
AD AGENCY COORDINATION
COMPETITIVE RESPONSE
PA/PR
MARKETING PLAN

LAW
PROJECT ALPHA



ACCOUNTABILITIES

CONTRACTS
FDA
LITIGATION COORDINATION
DOMESTIC/FOREIGN
REGULATORY ISSUES

ACCOUNTABILITIES

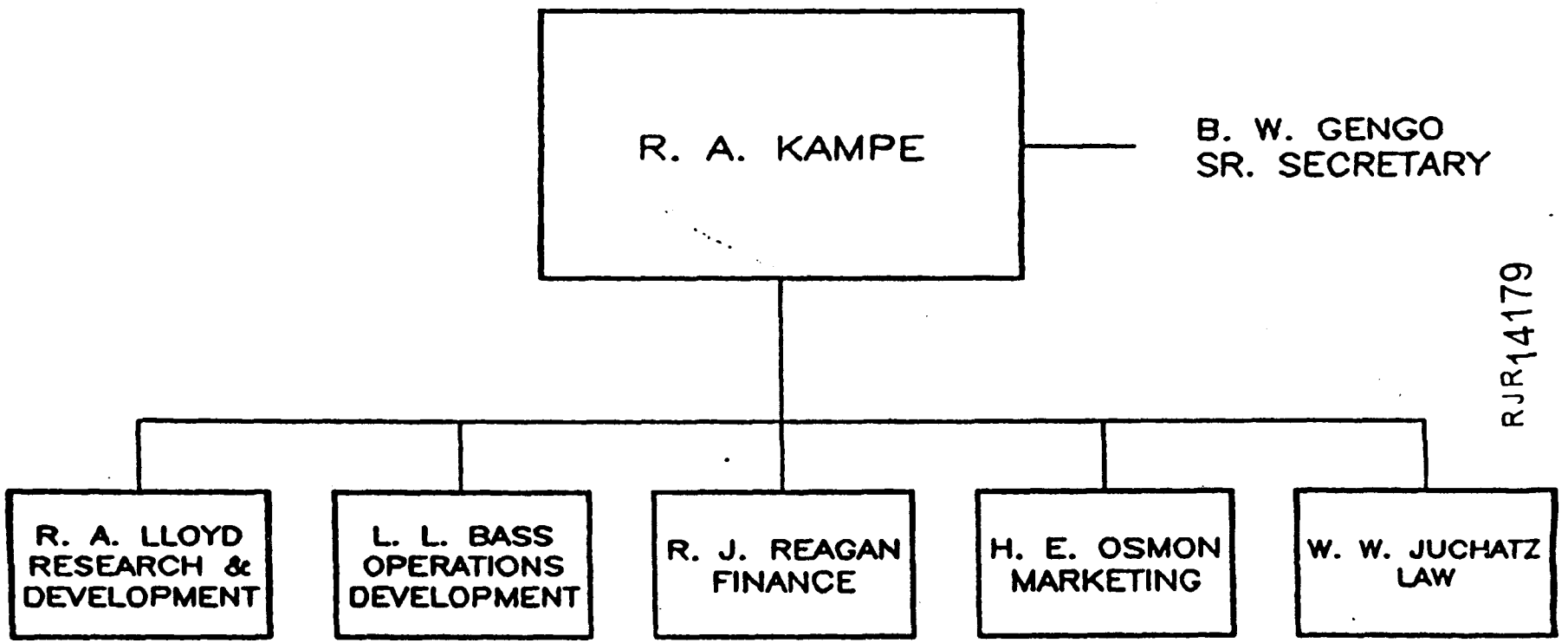
DOMESTIC PATENTS
FOREIGN PATENTS

PROJECT ALPHA

ORGANIZATIONAL

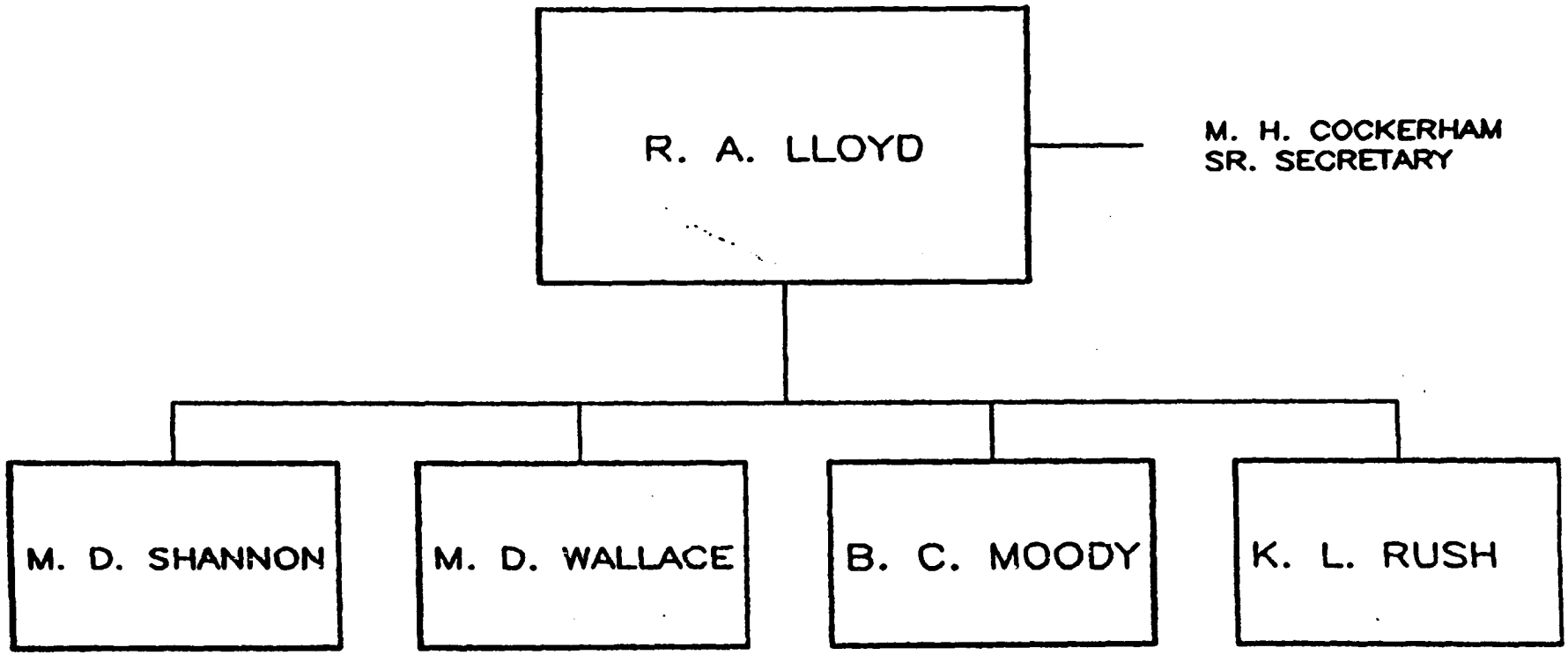
STRUCTURE

PROJECT ALPHA



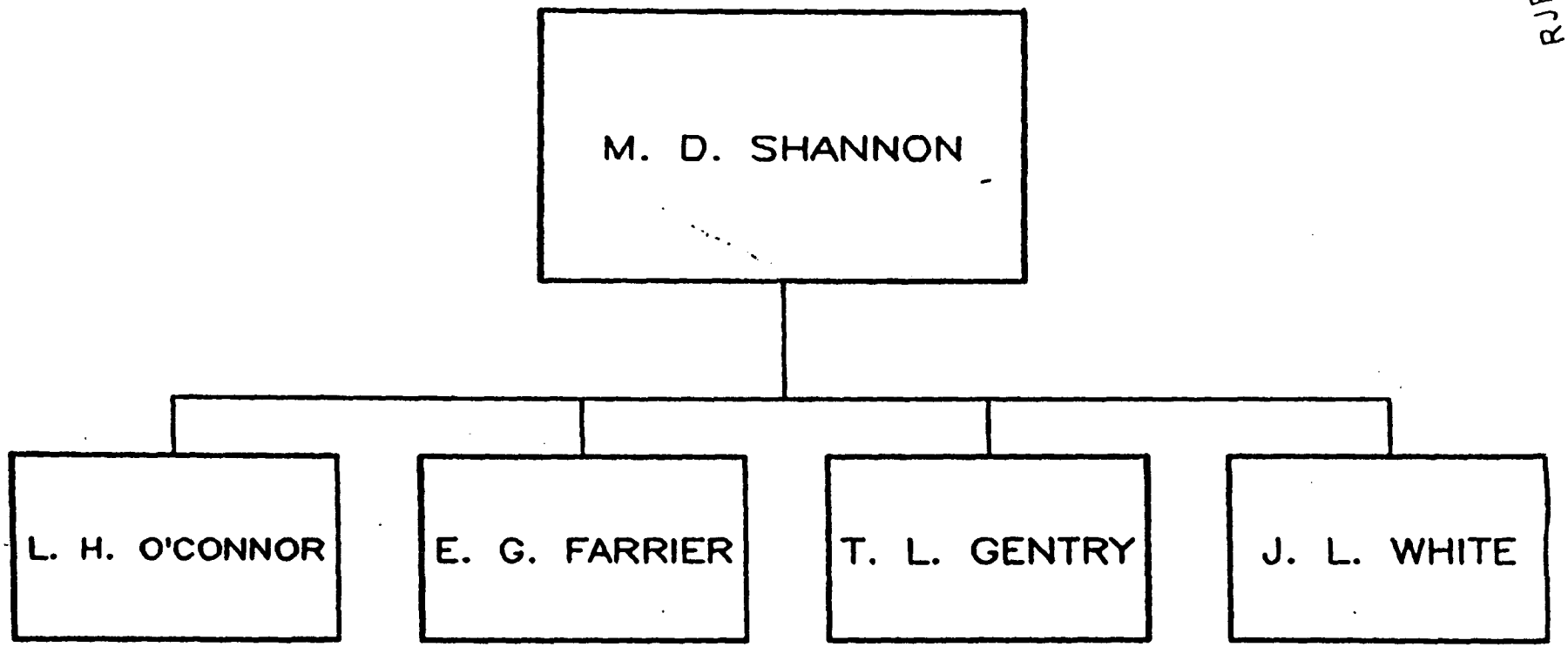
RJR14179

RESEARCH AND DEVELOPMENT
PROJECT ALPHA



RJR14180

PRODUCT DEVELOPMENT



ACCOUNTABILITIES

SYSTEM PERFORMANCE
- INTERIM SPECS
- DESIGN IMPROVEMENTS
- OPTIMIZATION
- FINAL SPECIFICATIONS

COMPONENT DEVELOPMENT
COST REDUCTION

ACCOUNTABILITIES

FUEL SOURCE
- TASTE/AROMA PROBLEM
- INTERIM PROCESS

CAPSULE
- IDENTIFY SUPPLIERS
- DETERMINE SPECS
- RECOMMEND OPTIONS

TROUBLE SHOOTING

ACCOUNTABILITIES

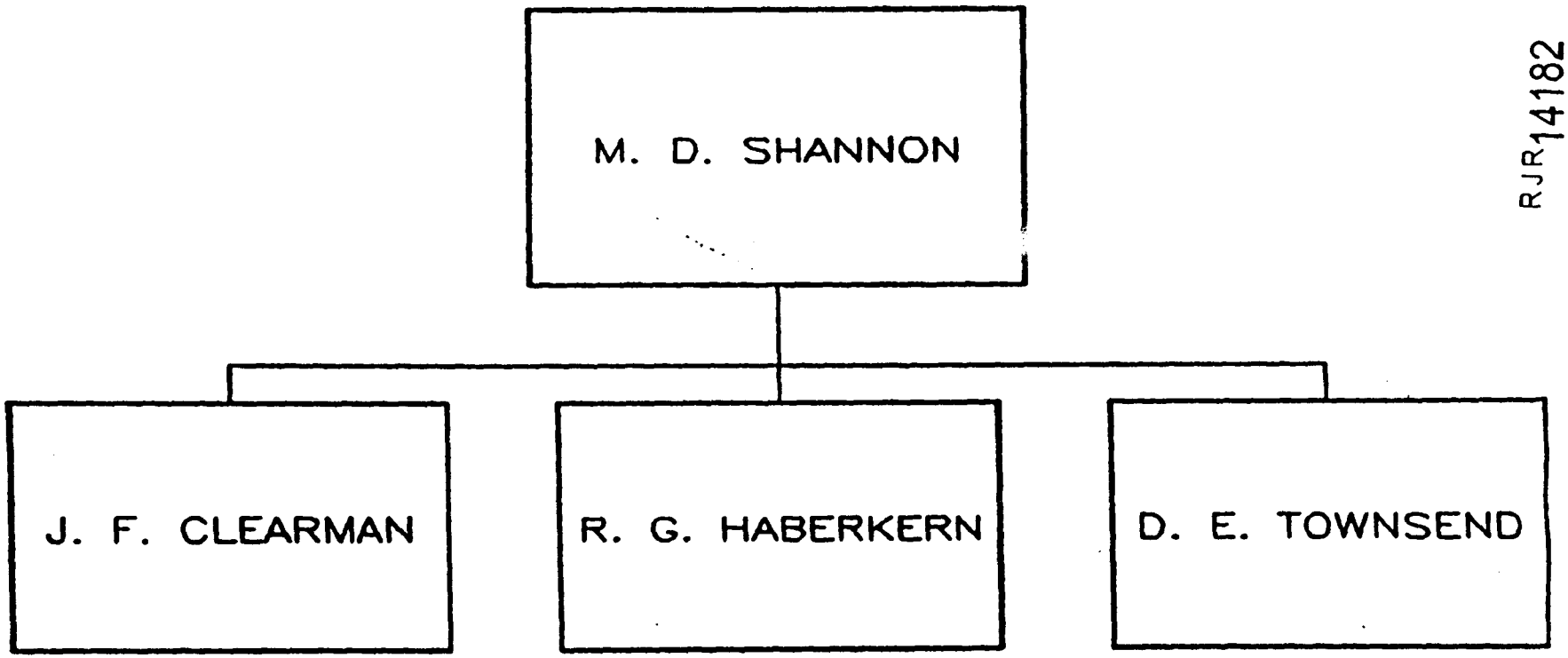
FLAVOR
- STRENGTH
- TOBACCO

TROUBLE SHOOTING

ACCOUNTABILITIES

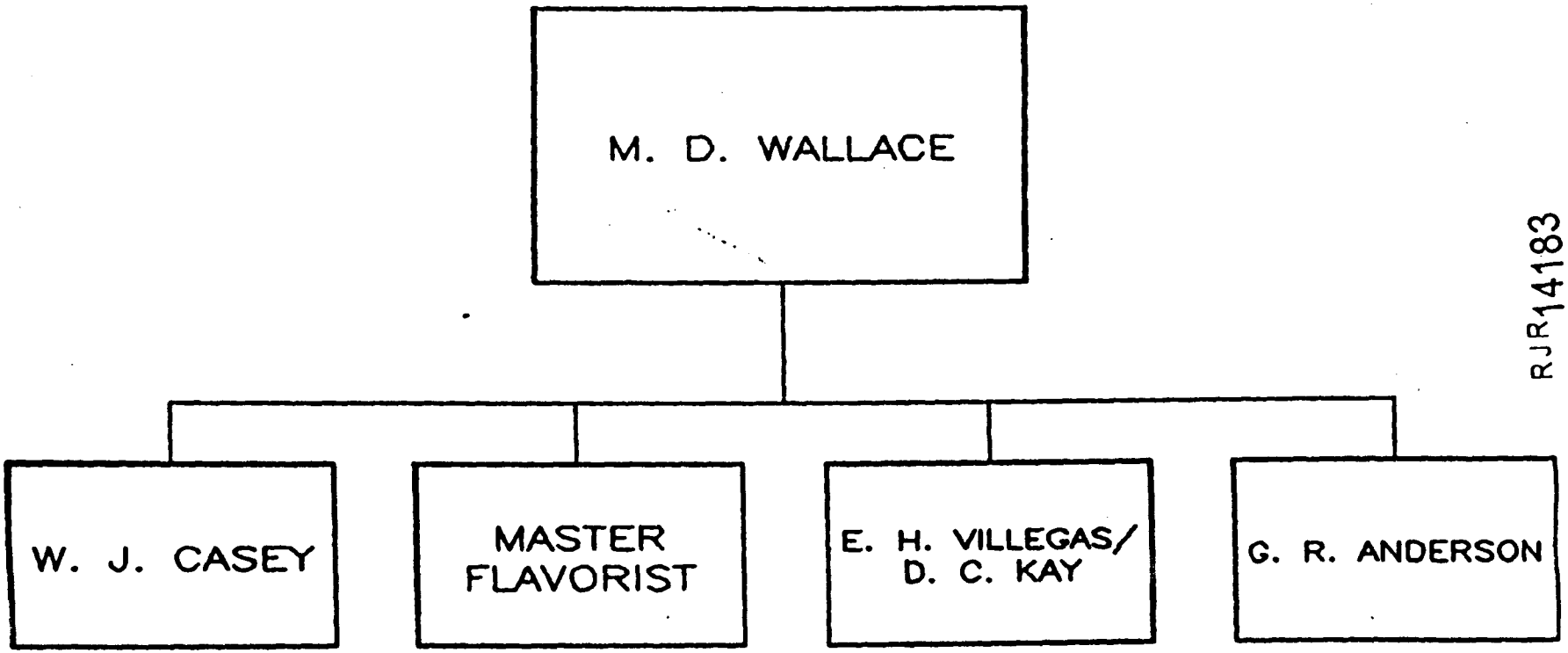
CO REDUCTION
ALTERNATE CONCEPTS

PRODUCT DEVELOPMENT



RJR14182

PRODUCT APPLICATIONS



ACCOUNTABILITIES

O. D. COORDINATION
- TOXICOLOGY STUDIES

TOBACCO RESEARCH
- NEW DESIGNS
- ANALYTICALS

ACCOUNTABILITIES

FLAVOR DEVELOPMENT
- MANAGE PERSONNEL
- DIRECT ACTIVITIES OF OUTSIDE CONTRACTORS
- EMPIRICAL RESEARCH

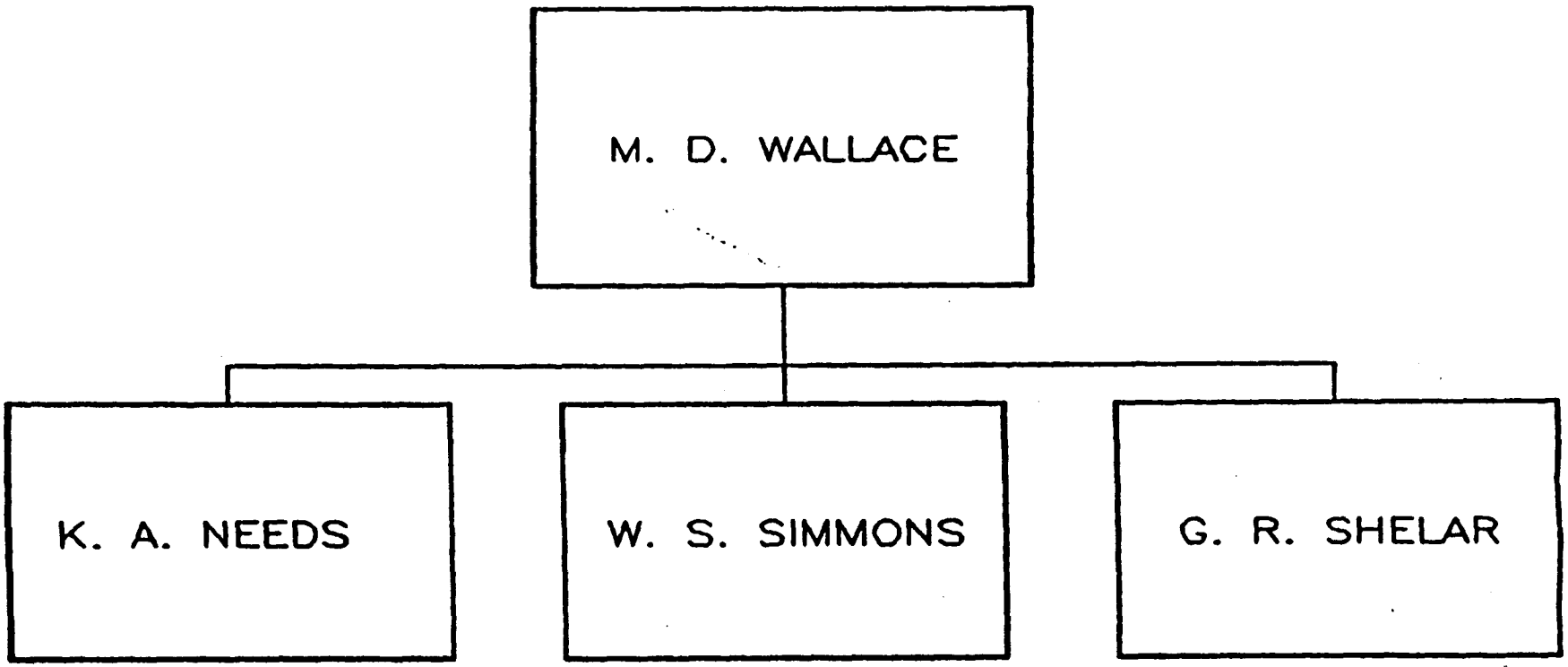
ACCOUNTABILITIES

PRODUCT STABILITY STUDIES
SHELF LIFE STUDIES

ACCOUNTABILITIES

DETERMINATION OF PRODUCT PROTECTION REQUIREMENTS
AID IN IMPLEMENTATION TO MARKETPLACE

PRODUCT APPLICATIONS



ACCOUNTABILITIES

IN–HOUSE SENSORY TESTING
COORDINATE CONSUMER TESTING

ACCOUNTABILITIES

TOXICOLOGICAL STUDIES

ACCOUNTABILITIES

TOBACCO RESEARCH
- MODEL DEVELOPMENT
- TASTE/SATISFACTION
- NEW DESIGNS
- LIAISON TO PRODUCT DEVELOPMENT GROUP

RJR 14184

50495 5046

OPERATIONS DEVELOPMENT
PROJECT ALPHA

RJR14185

L. L. BASS

J. S. BURGESS
SR. SECRETARY

W. B. SCANTLAND

B. L. HESTER

M. N. BAKER

D. G. HUBBARD

ACCOUNTABILITIES

PLANNING
COORDINATION
SCHEDULING
R & D LIASON

51696 0960

ACCOUNTABILITIES

SUPPORTING PROCESSES
- FUEL SOURCE
- CAPSULE PREPARATION
- MARUMERIZED
- SUBSTRATE PRODUCTION

INSRUMENTATION AND CONTROL

ACCOUNTABILITIES

MECHANICAL DESIGN
- BENCH SCALE EQUIPMENT
- GLASS FIBER MACHINERY
- CAPSULE MACHINERY
- PACKERS

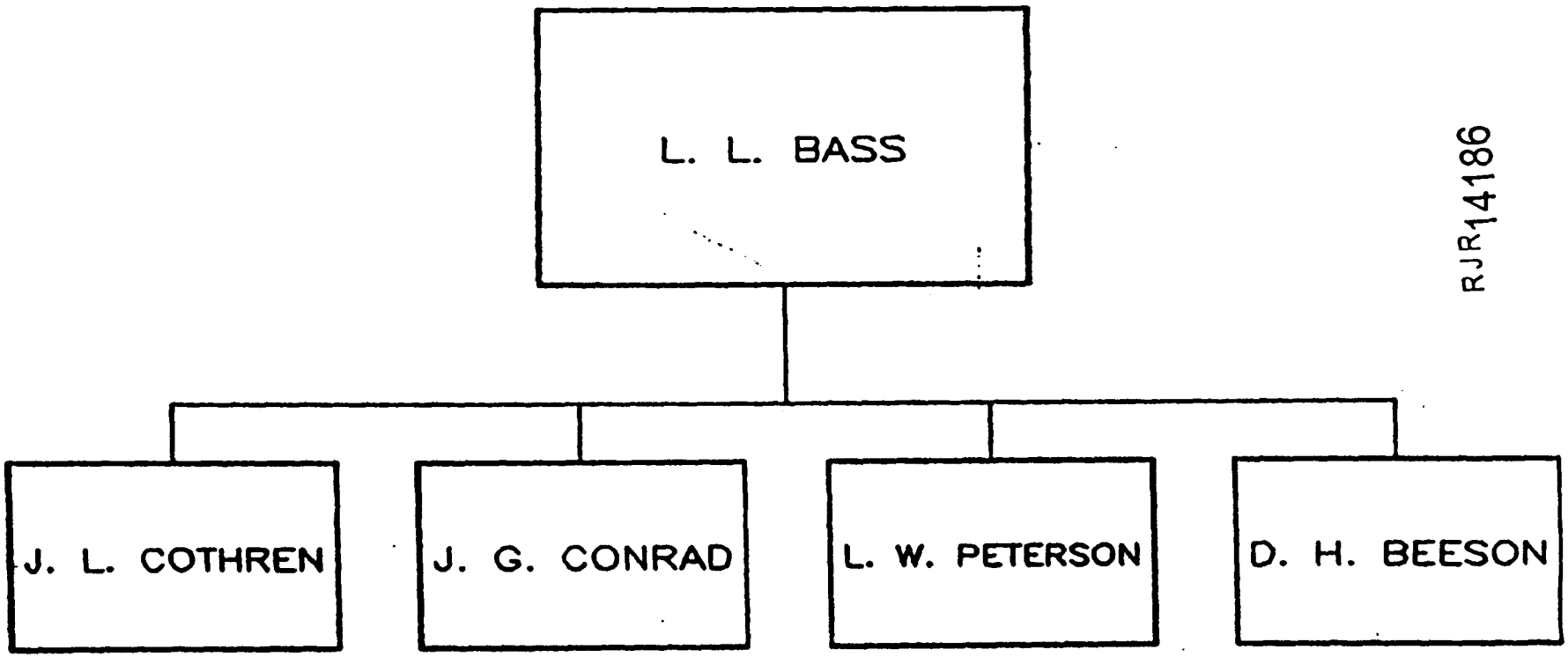
MACHINERY DEVELOPMENT
- PRODUCTION CONCEPTS
- VENDOR LIASON

ACCOUNTABILITIES

FACILITIES COORDINATION
- DIRECT ENGINEERING, DESIGN, CONSTRUCTION
- SPACE PLANNING
- MACHINERY LAYOUTS
- COST ESTIMATING
- PRODUCTION REQUIREMENTS TRANSLATION

50495

OPERATIONS DEVELOPMENT
PROJECT ALPHA



RJR14186

ACCOUNTABILITIES

START UP PHASE:
- STAFFING/TRAINING
- INITIAL PRODUCTION
- INVENTORY CONTROL
- PRODUCTION PLANNING
- PRODUCTION WASTE

ACCOUNTABILITIES

FINANCIAL SUPPORT
- BUDGETING
- COST ESTIMATING
- AR/CA

PERSONNEL SUPPORT
SECURITY
OFFICE SERVICES
PLANNING

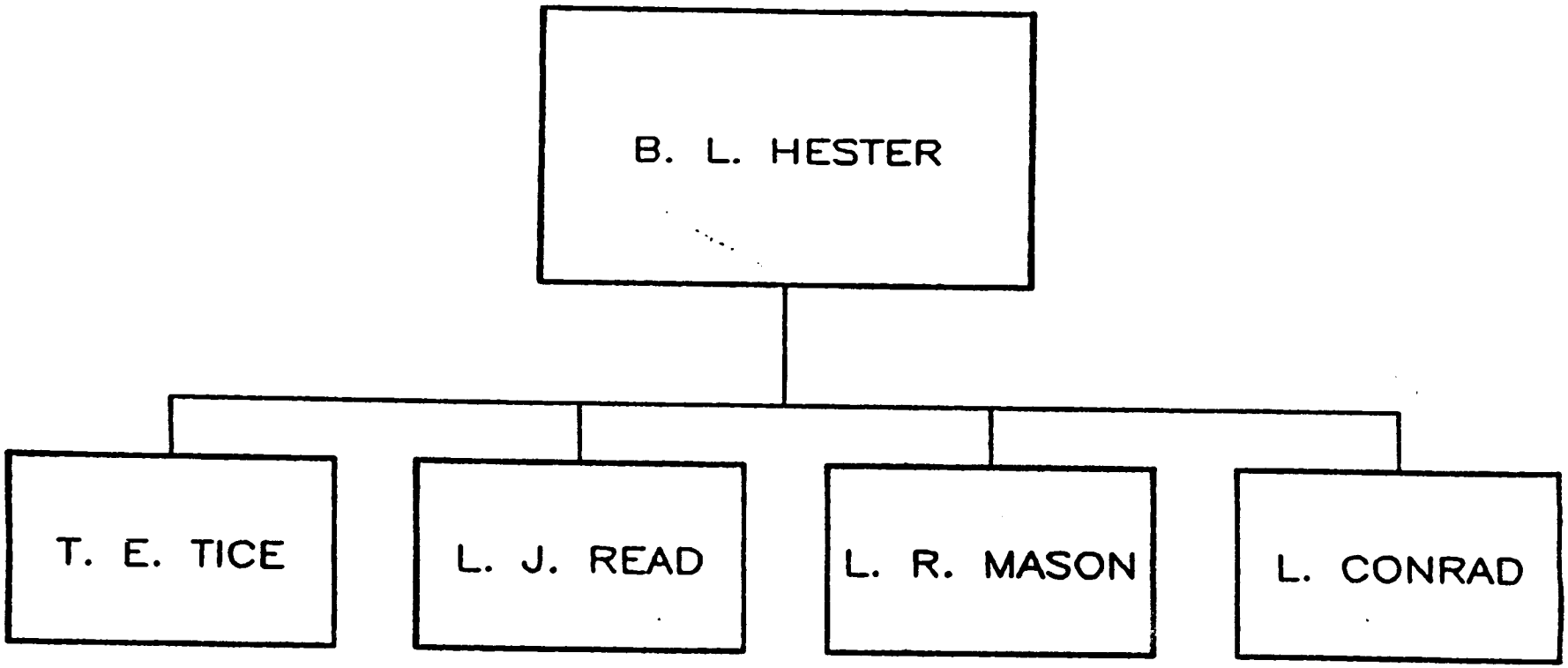
ACCOUNTABILITIES

DEVELOP QA PROGRAM
PRODUCT SPECIFICATIONS/
R & D INTERFACE
QA STAFFING/TRAINING
QA EQUIPMENT/
FACILITIES PLANNING

ACCOUNTABILITIES

MACHINERY DELIVERY/
INSTALLATION SCHEDULING
MACHINERY START-UP
INSTALLATION COST
ESTIMATING
COORDINATION

INSTRUMENTATION CONTROLS AND SUPPORTING PROCESSES



ACCOUNTABILITIES

INSTRUMENTATION
- DEVELOPMENT FOR PRODUCTION
- DEVELOPMENT FOR QA
- IDENTIFY SUPPLIERS

ACCOUNTABILITIES

FUEL SOURCE PRODUCTION
- SCALE-UP
- DEVELOP HIGH-SPEED ALTERNATIVE

SUPPORTING PROCESSES
- SCALE-UP
- IDENTIFY FACILITY NEEDS
- IDENTIFY QA NEEDS

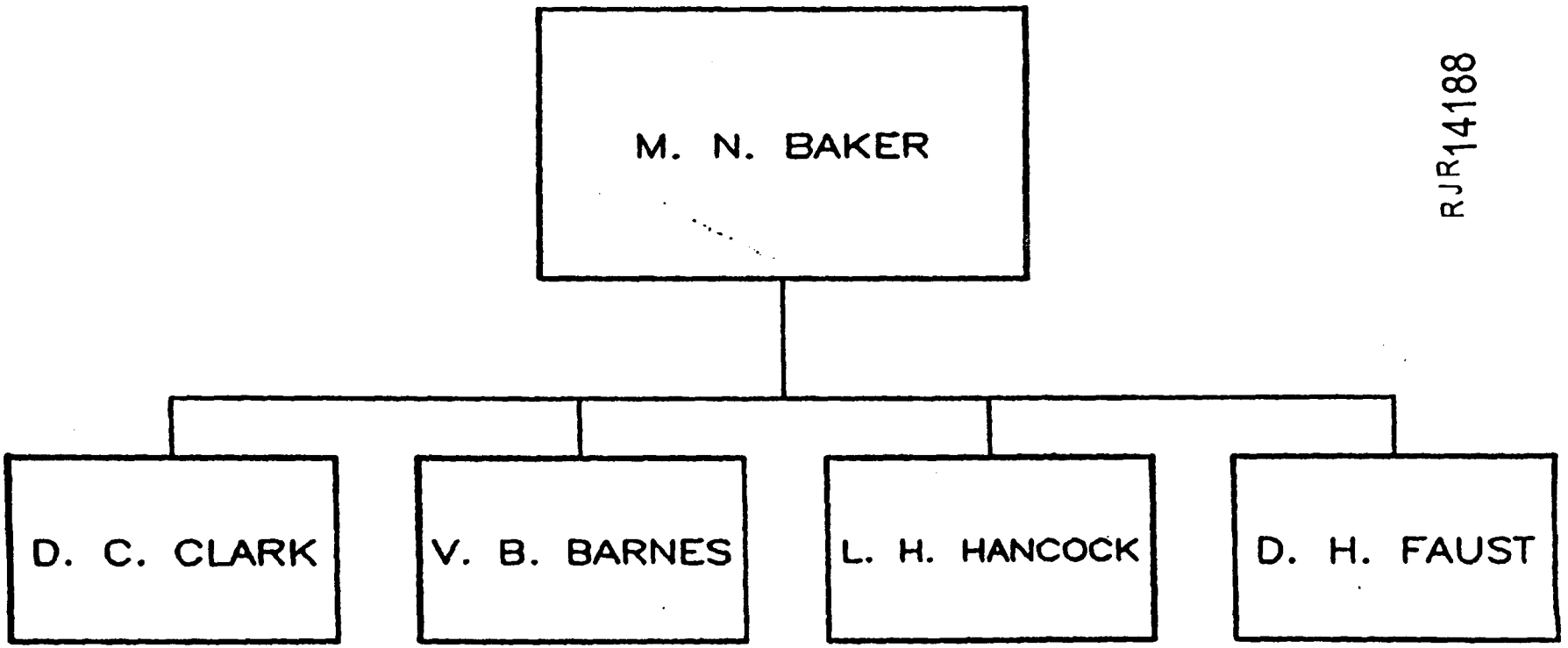
ACCOUNTABILITIES

FUEL SOURCE PRODUCTION
- SCALE-UP
- DEVELOP HIGH-SPEED ALTERNATIVE

ACCOUNTABILITIES

SUPPORTING PROCESSES
- DEVELOPMENT
- DESIGN

MECHANICAL DESIGN



ACCOUNTABILITIES

BENCH SCALE EQUIPMENT
GLASS FILTER TUBE MACHINE

ACCOUNTABILITIES

CAPSULE MACHINERY
- IDENTIFY REQUIREMENTS
- VENDOR LIASON
- DEVELOP PRODUCTION CONCEPT

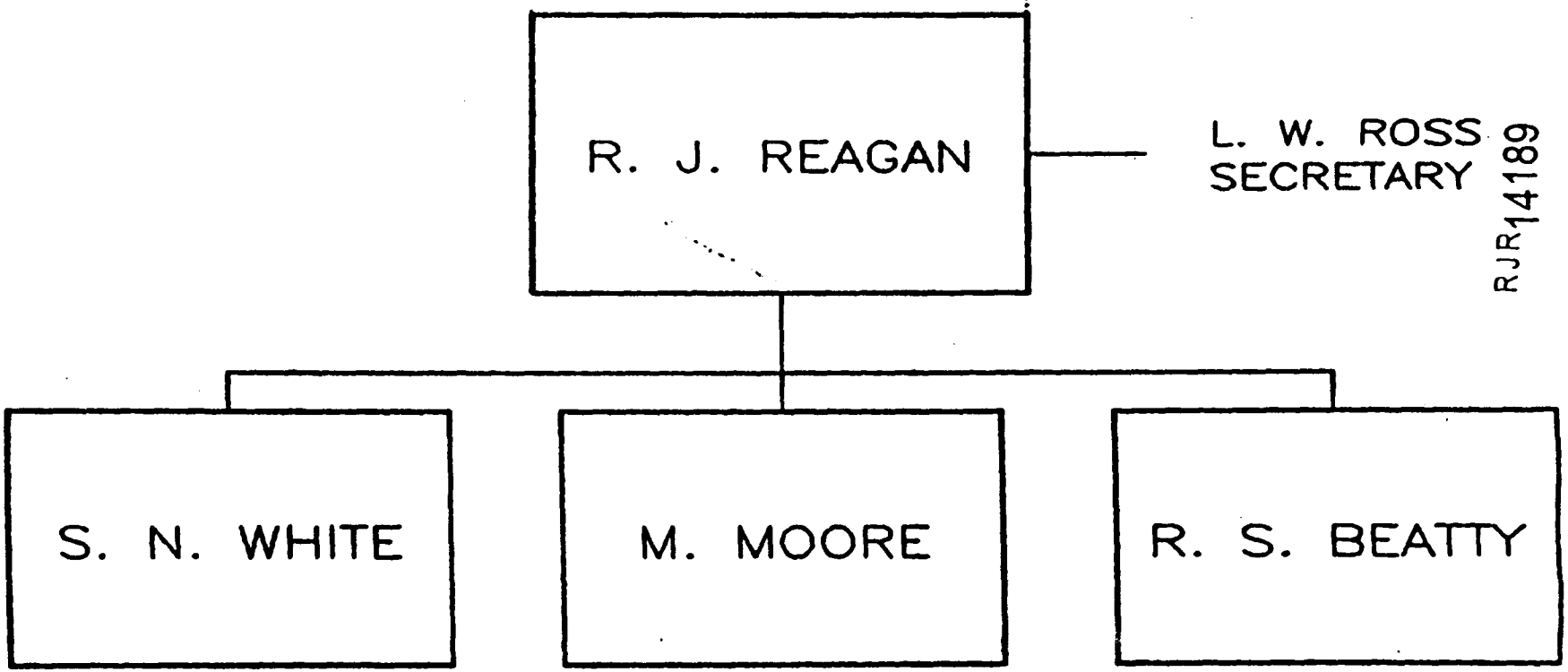
ACCOUNTABILITIES

GLASS FILTER TUBE MACHINERY
- IDENTIFY REQUIREMENTS
- VENDOR LIASON
- DEVELOP PRODUCTION CONCEPT

ACCOUNTABILITIES

PACKERS
- IDENTIFY REQUIREMENTS
- VENDOR LIASON
- DEVELOP PRODUCTION CONCEPT

FINANCE AND ADMINISTRATION - PROJECT ALPHA



ACCOUNTABILITIES

PROJECT ACCOUNTING
PROJECT REPORTING
AD AGENCY FINANCIAL CONTACT
AUTHORIZATIONS (AR/CA)
PLAN/BUDGET COORDINATION
ADMINISTRATIVE COORDINATION

ACCOUNTABILITIES

PRODUCT COSTING
FINANCIAL ANALYSIS
- CONTRACTS
- OVERALL PROJECT
- ROI
- SENSITIVITY ANALYSIS
- RISK ANALYSIS

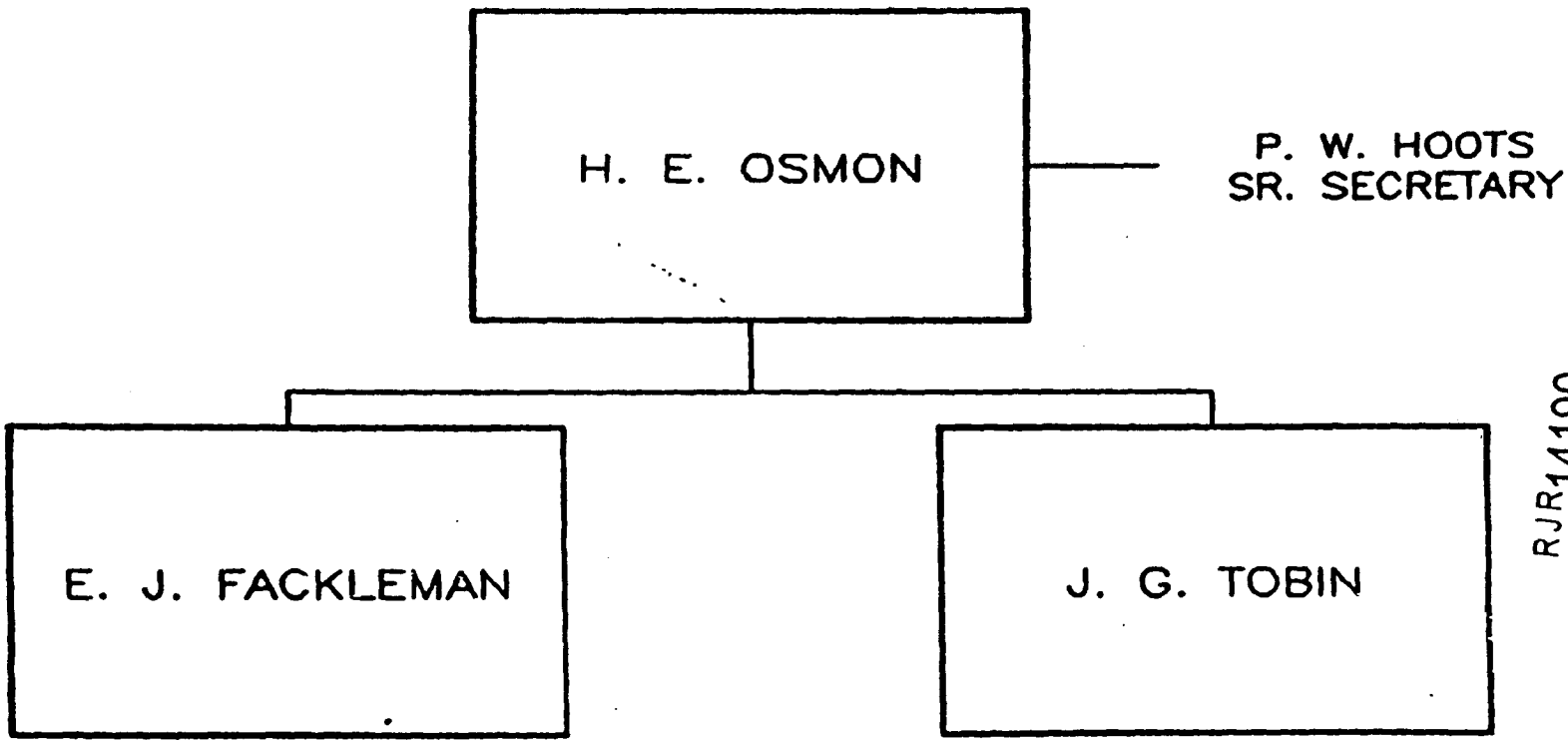
PRODUCT PROFITABILITY

ACCOUNTABILITIES

ORDER OF MATERIALS
- FUEL SOURCE
- GLASS FIBER
- CAPSULE
- MOUTHPIECE
- SUPPORTING PROCESSES

PRODUCTION EQUIPMENT
FACILITIES NEEDS

MARKETING
PROJECT ALPHA



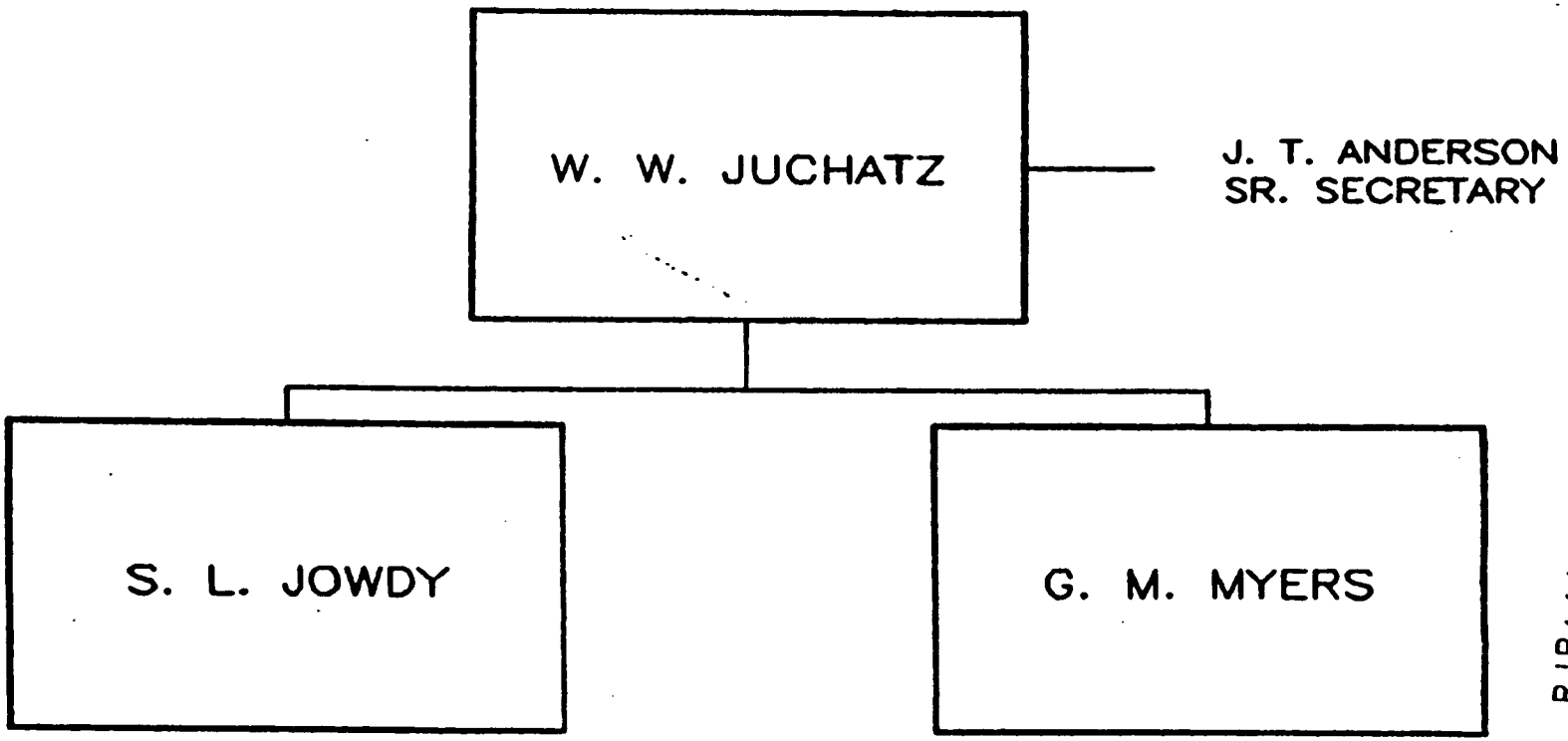
ACCOUNTABILITIES

PRODUCT TESTING
NAME TESTING
PACKAGE TESTING
ADVERTISING EVALUATION
PRICE RESEARCH

ACCOUNTABILITIES

ADVERTISING COPY/CAMPAIGN
NAME SELECTION
PACKAGE DESIGN
AD AGENCY COORDINATION
COMPETITIVE RESPONSE
PA/PR
MARKETING PLAN

LAW
PROJECT ALPHA



RJR14191

ACCOUNTABILITIES

CONTRACTS
FDA
LITIGATION COORDINATION
DOMESTIC/FOREIGN
REGULATORY ISSUES

ACCOUNTABILITIES

DOMESTIC PATENTS
FOREIGN PATENTS

US005220930A

United States Patent [19]

Gentry

[11] Patent Number: 5,220,930

[45] Date of Patent: Jun. 22, 1993

[54] CIGARETTE WITH WRAPPER HAVING ADDITIVE PACKAGE

[75] Inventor: Jeffery S. Gentry, Pfafftown, N.C.

[73] Assignee: R. J. Reynolds Tobacco Company, Winston-Salem, N.C.

[21] Appl. No.: 842,276

[22] Filed: Feb. 26, 1992

[51] Int. Cl.[5] A24D 1/02

[52] U.S. Cl. 131/365; 131/331

[58] Field of Search 131/360, 331, 362, 365, 131/373, 374

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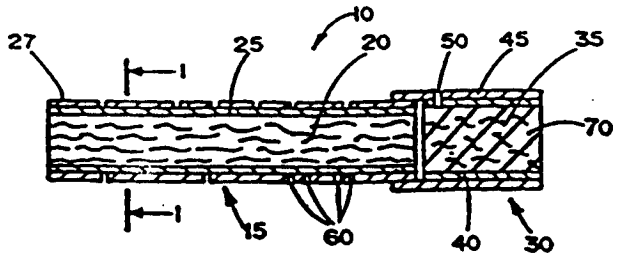
Primary Examiner—V. Millin

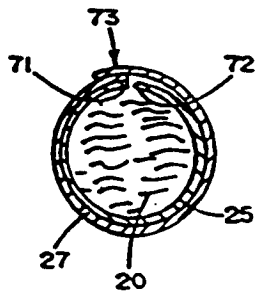
Assistant Examiner—William M. Pierce

[57] ABSTRACT

A cigarette includes a charge or roll of smokable material (e.g., tobacco cut filler) circumscribed by at least one layer of paper wrapping material to form a tobacco rod. A certain cigarette includes an outer wrapping material which circumscribes and overwraps an inner wrapping material. At least one paper wrapping material of the tobacco rod includes an additive package. The additive package includes at least one water soluble salt which is applied in a water soluble form. For example, a paper wrapper including wood pulp fiber and calcium carbonate filler material is treated with an aqueous solution of calcium acetate, potassium chloride and potassium acetate. The cigarette is capable of sustaining smolder under FTC smoking conditions while yielding very low levels of visible sidestream smoke.

79 Claims, 2 Drawing Sheets





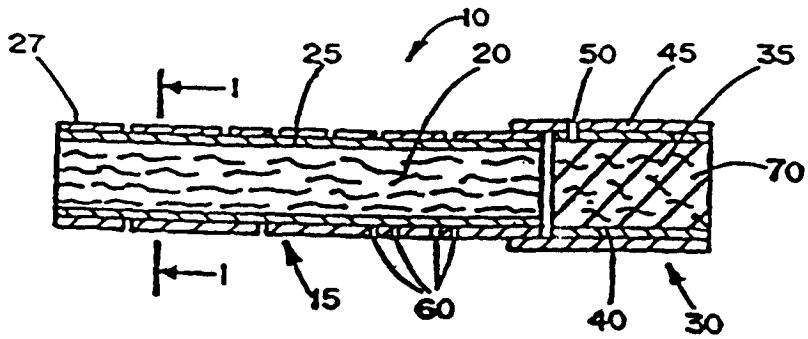


FIG. 1

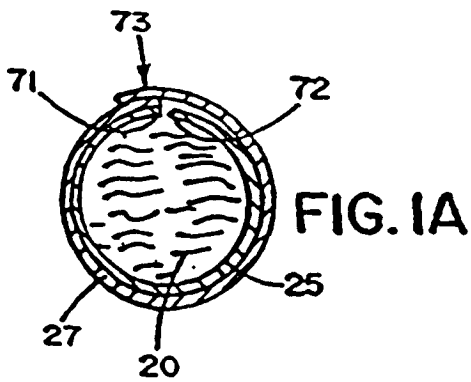


FIG. 1A

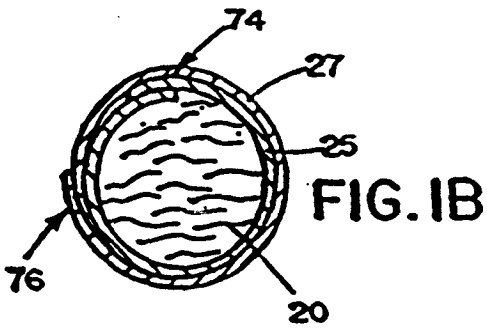


FIG. 1B

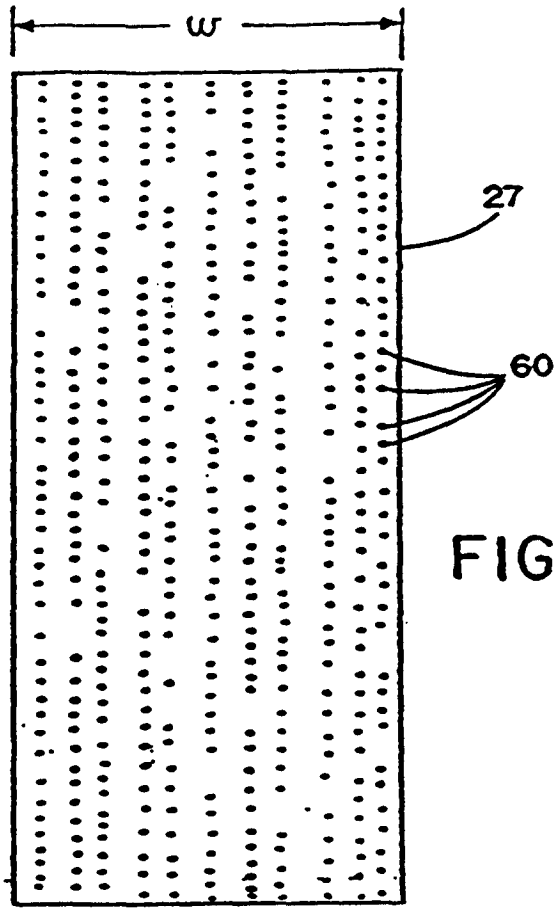


FIG. 2

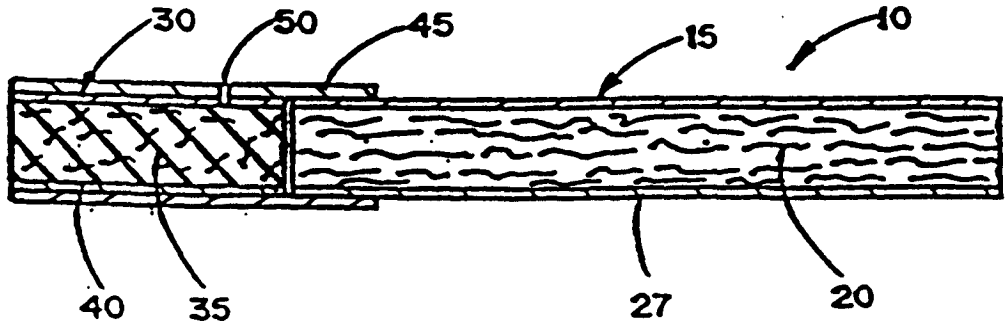


FIG. 3

CIGARETTE WITH WRAPPER HAVING ADDITIVE PACKAGE

BACKGROUND OF THE INVENTION

The present invention relates to cigarettes which burn tobacco, and in particular to cigarettes, which when smoked, generate low amounts of sidestream "tar" and sustain smolder at least during FTC smoking conditions.

Popular smoking articles, such as cigarettes, have a substantially cylindrical rod shaped structure and include a charge, roll or column of smokable material such as shredded tobacco (e.g., in cut filler form) surrounded by a paper wrapper thereby forming a so-called "tobacco rod." Normally, a cigarette has a cylindrical filter element aligned in an end-to-end relationship with the tobacco rod. Typically, a filter element includes cellulose acetate tow circumscribed by plug wrap, and is attached to the tobacco rod using a circumscribing tipping material. It also has become desirable to perforate the tipping material and plug wrap, in order to provide dilution of drawn mainstream smoke with ambient air.

Cigarettes are employed by the smoker by lighting one end thereof and burning the tobacco rod. The smoker then receives mainstream smoke into his/her mouth by drawing on the opposite end (e.g., the filter end) of the cigarette. During the time that the cigarette is not being drawn upon by the smoker, it remains burning, and sidestream smoke is generated. Sidestream smoke is smoke which directly enters the atmosphere from the lit end of the cigarette. Sidestream smoke diffuses into the atmosphere, and the characteristic visible nature thereof may be perceived negatively by some individuals. Thus, certain cigarette smokers have indicated a desire to decrease the levels of visible sidestream smoke generated by their cigarettes.

The relative amount of visible sidestream smoke generated by a burning cigarette is related to the amount of sidestream "tar" generated by that burning cigarette. Typical cigarettes of about 84 mm length (e.g., having a tobacco rod length of about 57 mm and a filter element length of about 27 mm) often yield about 25 to about 35 mg of sidestream "tar" per cigarette. See, Proctor, et al., *Analyst*, Vol. 113, p. 1509 (1988), for an apparatus and technique for determining the sidestream "tar" of a cigarette.

Numerous cigarettes which reportedly yield relatively low levels of visible sidestream smoke have been proposed. See, for example, U.S. Pat. Nos. 4,108,151 to Martin; 4,225,636 to Cline; 4,231,377 to Cline; 4,407,308 to Baker; 4,420,002 to Cline; 4,450,847 to Owens; 4,461,311 to Mathews; 4,561,454 to Guess; 4,624,268 to Baker, et al.; 4,637,410 to Luke; 4,805,644 to Hampl, Jr., et al.; 4,881,557 to Martin; 4,915,118 to Kaufman, et al.; 4,924,888 to Perfetti, et al.; 4,941,485 to Perfetti, et al.; 4,998,541 to Perfetti, et al.; 5,060,675 to Milford et al; and 5,065,777 to Owens, Jr.; as well as European Patent Application No. 402,059 and U.S. Pat. application Ser. Nos. 661,747, filed Feb. 27, 1991 and 759,266 filed Oct. 3, 1991.

It would be desirable for the Cigarette manufacturer to provide a good tasting cigarette which is capable of (i) providing good smoking satisfaction, (ii) sustaining smolder at least during FTC smoking conditions, (iii) generating low levels of sidestream "tar" and hence low levels of visible sidestream smoke, and (iv) exhibiting desirable performance attributes (e.g., exhibiting a strong, cohesive ash) during the smoking period.

SUMMARY OF THE INVENTION

The present invention relates to a cigarette which delivers good tobacco smoking flavor, pleasure and satisfaction, while being capable of generating relatively low levels of sidestream "tar." Preferred cigarettes exhibit extremely low levels of visible sidestream smoke as well as low levels of sidestream odor. Cigarettes of the present invention (i) have a weight which is not overly excessive, (ii) yield an acceptable ash and fire cone, (iii) yield acceptable smolder properties, and (iv) yield a burn rate and puff count which are acceptable. Further, such cigarettes have a tendency to (i) burn back uniformly during use, and (ii) not provide visible staining of the outer wrap immediately behind the char line during use, and (iii) yield an ash of acceptable color. Preferred cigarettes burn back slowly during static smolder resulting in the combustion of a relatively low amount of smokable material, while maintaining a tendency to sustain smolder.

Certain cigarettes of the present invention include a charge or roll of smokable material contained in a circumscribing wrapping material to form a so-called "tobacco-rod". The smokable material is a smokable filler material comprising tobacco cut filler. Normally, the smokable material is all tobacco cut filler material, and preferably that cut filler material has been cased and/or top dressed. The wrapping material is a paper which includes a water soluble additive package (i.e., the additive package includes water soluble components). The additive package is in intimate contact with the wrapping material. The amount of additive package in intimate contact with the wrapping material typically ranges from about 5 to about 40 percent, based on the final dry weight of the wrapping material including the additive package. The additive package includes at least one water soluble alkali earth metal ion component. The additive package most preferably includes at least one water soluble alkali metal ion component. The additive package includes at least one water soluble organic anion component. The additive package most preferably includes at least one water soluble inorganic anion component. Most preferably, the water soluble alkali earth metal ions and the organic anions provide the primary components of the additive package. If desired, other components in addition to the additive package can be incorporated into the wrapping material. For example, flavor and aroma precursors, flavoring agents, organic acids, and the like, also can be incorporated into the wrapping material.

A highly preferred additive package includes (i) optional alkali metal ions and (ii) alkali earth metal ions, such that the ratio of equivalents of (i) to (ii) ranges from about 0 to about 1.2, typically about 0.05 to about 1, often about 0.1 to about 0.7, and frequently about 0.2 to about 0.5. A highly preferred additive package also includes (iii) optional inorganic anions and (iv) organic anions, such that the ratio of equivalents of (iii) to (iv) ranges from about 0 to about 1, typically about 0.05 to about 0.7, often about 0.1 to about 0.5, and frequently about 0.1 to about 0.3. In addition, for an additive package, the total number of equivalents of (i) plus (ii) equals the total number of equivalents of (iii) plus (iv). As used herein, the term "equivalents" means the number of moles of a component ion multiplied by the charge of

that component (e.g., the charge of a calcium ion is 2 and the charge of an acetate ion is 1).

By "water soluble" in referring to the components of the additive package is meant that the components of the package form a thermodynamically stable mixture when combined with an aqueous liquid, have a significant ability to dissolve in an aqueous liquid, and do not form precipitates to any significant degree when present in an aqueous liquid. The water soluble package can be provided by dissolving suitable salts in an aqueous liquid, and/or by neutralizing corresponding acids and bases in an aqueous liquid. Particularly desirable salts are those that have a solubility in water of greater than about 10 weight percent at 25° C. As used herein, the term "water soluble" in referring to the components of the additive package is meant that the components are in a water soluble form (i.e., as opposed to an essentially water insoluble precipitate) at least until the point at which those components are applied to, are incorporated into, or are otherwise provided in intimate contact with the wrapping material. As such, it is possible that water soluble components can take an essentially water insoluble form once those components are incorporated into the wrapping material (i.e., certain precipitates comprising at least one of the components of the additive package can form after the components of the additive package are applied to the wrapping material). However, it is most desirable that a majority by weight of the components of the additive package remain in a water soluble form (i.e., as water soluble salts) while those components are in intimate contact with the wrapping material, during the useful lifetime of the wrapping material (i.e., during the period up until the time that a cigarette incorporating that wrapping material, stored and handled under normal conditions, is smoked).

Certain cigarettes of the present invention include a charge or roll of smokable material contained in two layers of circumscribing outer wrapping materials to form a tobacco rod. The tobacco rod is such that a first (i.e., inner) wrapping material circumscribes the smokable material, and a second (i.e., outer) wrapping material circumscribes the first wrapping material. One or both of the wrapping materials can be a paper incorporating the additive package of the type previously described. The smokable material is a smokable filler material comprising tobacco cut filler material. Normally, the smokable material is all tobacco cut filler material, and preferably that cut filler material has been cased and/or top dressed.

The second or outer layer of wrapping material surrounding the roll of smokable material preferably is a paper incorporating the additive package of the type previously described. The second wrapping material incorporating the additive package most desirably has a moderate to relatively low inherent air permeability. Certain wrapping materials incorporating the additive package exhibit a porosity or air permeability below about 30 CORESTA units, normally below about 25 COESTA units, often below about 20 CORESTA units, frequently below about 15 CORESTA units, and even about 10 CORESTA units or less. A CORESTA unit is a measure of the linear air velocity which passes through a 1 cm² area of wrapper at a constant pressure of 1 centibar. See CORESTA Publication ISO/TC 0126/SC I N159E (1986). The second wrapping material can have a net porosity which is greater than the inherent porosity thereof. For example, the second wrapping material can be perforated (e.g., electrostatically perforated) to have a net porosity of about 50 to about 225 CORESTA units.

The first or inner wrapping material surrounding the roll of smokable material is a paper, and most preferably a paper that is different in composition from the outer wrapping material. The paper can vary, but one preferred paper is a paper containing a tobacco material. Certain first wrapping materials which contain a tobacco material, preferably have a sufficiently high level of at least one salt additive which can act to sustain static burn of the tobacco rod, at least when such cigarettes are smoked under FTC smoking conditions. The salt can be an essentially water insoluble inorganic salt (e.g., particles of calcium carbonate), a water soluble inorganic salt (e.g., potassium chloride), or a water soluble organic salt (e.g., potassium citrate). Mixtures of essentially water insoluble and water soluble salts can be employed. In certain circumstances, the inner wrapping material can incorporate the additive package of the type previously described. Certain inner wrapping materials can contain a carbonaceous material. The first wrapping material most preferably exhibits an inherent air permeability above about 20 CORESTA units. The first wrapping material can be perforated to yield a wrapping material having yet higher net porosity.

Cigarettes of the present invention preferably each include a filter element which acts as a mouthpiece.

Cigarettes can be air diluted (e.g., by perforating the tipping material in the region which overlies the filter elements or by other such air dilution means). Normally, preferred cigarettes employ moderate to low efficiency filter elements. See, Keith in Schemeltz's *The Chemistry of Tobacco and Tobacco Smoke, p.* 157 (1972). Normally, the filter element is ventilated to provide a cigarette having an air dilution between about 25 and about 75 percent. As used herein, the term "air dilution" is the ratio (expressed as a percentage) of the volume of air drawn through the air dilution means to the total volume of air and smoke drawn through the cigarette and exiting the extreme mouthend portion of the cigarette. See, Selke, et al., *Beitr. Zur Tabak. In.*, Vol. 4, p. 193 (1978).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a cigarette of the present invention;

FIGS. 1A and 1B are cross-sectional radial views of the cigarette shown in FIG. 1 taken along lines 1—1 in FIG. 1;

FIG. 2 is a diagrammatic illustration of one type of wrapping material which can be employed to provide a tobacco rod of the present invention; and

FIG. 3 is a longitudinal sectional view of a cigarette of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An embodiment of a cigarette of the present invention is shown in FIG. 1. The cigarette 10 includes a generally cylindrical rod 15 of a column of smokable material 20, such as tobacco cut filler, contained in a first circumscribing inner wrapping material 25 and a second or outer wrapping material 27 circumscribing the first wrapping material. The first and second circumscribing wrapping materials directly contact one another (i.e., the inner surface of the outer wrapping material contacts the outer surface of the inner wrap-

ping material). As such, the outer wrapping material overwraps the inner wrapping material. The rod 15 is hereinafter referred to as a "tobacco rod." The ends of the tobacco rod 15 are open to expose the smokable material. The outer wrapping material 27 most preferably includes an additive package which is described in greater detail hereafter. If desired, the inner wrapping material 25 can include an additive package which is described in greater detail hereafter. Although the additive package of the inner wrapping material 25 is optional, and not particularly preferred, inner wrapping material incorporating an additive package can be employed with an outer wrapping material which either includes or is absent of an additive package.

The cigarette 10 also includes a filter element 30 positioned adjacent one end of the tobacco rod 15 such that the filter element and tobacco rod are axially aligned in an end-to-end relationship, preferably abutting one another. Filter element 30 has a generally cylindrical shape, and the diameter thereof is essentially equal to the diameter of the tobacco rod. The filter element includes a filter material (e.g., triacetin plasticized cellulose acetate tow) 35 circumscribed by a paper plug wrap 40. The ends of the filter element are open to permit the passage of air and smoke therethrough.

The filter element 30 is attached to the tobacco rod 15 by tipping material 45 which circumscribes both the entire length of the filter element and an adjacent region of the tobacco rod. The inner surface of the tipping material 45 is fixedly secured to the outer surface of the outer plug wrap 40 and the outer surface of the wrapping material 25 of the tobacco rod, using a suitable adhesive. A ventilated or air diluted smoking article is provided with an air dilution means, such as a series of perforations 50, each of which extend through the tipping material and plug wrap.

Referring to FIGS. 1 and 2, one type of outer wrapping material 27 has a width w (shown in FIG. 2) which is equal to the circumference of the cigarette plus the lap zone of the glue line which ultimately results during cigarette manufacture. One type of second wrapping material 27 includes a series of perforations 60 which extend in a linear fashion along the longitudinal length of thereof. Alternatively, other configurations, such as a random perforation pattern, can be provided. The size, number and relative positioning of the individual perforations 60 can vary depending upon the desired characteristics of the cigarette which has the wrapping material incorporated therein. The individual perforations are shown as enlarged in FIGS. 1 and 2.

Referring to FIG. 1A, smokable material 20 is contained in a first circumscribing inner wrapping material 25, and a second outer wrapping material 27 circumscribes the first wrapping material. The first wrapping material 25 is formed into a circular shape such that the ends 71, 72 of the sides thereof abut one another. The ends 71, 72 of wrapping material 25 can abut one another (as shown in FIG. 1A), nearly abut one another, or slightly overlap one another. The second wrapping material 27 includes a lap zone 73 including a suitable adhesive therebetween so as to form a secure outer wrapper. As such, the width of the inner wrapping material is less than that of the outer wrapping material. A cigarette rod having such a configuration can be provided by supplying paper wrappers from two bobbins on a suitably equipped cigarette making machine, positioning the inner wrapping material on top of the outer wrapping material, passing the two wrapping materials so positioned through the garniture region of the cigarette making machine, and forming the tobacco rod. Equipment for providing a cigarette in such a manner is described in U.S. Pat. application Ser. Nos. 609,975, filed Nov. 6, 1990, and 756,023, filed Sep. 6, 1991, which are incorporated herein by reference. Other equipment for manufacturing a cigarette in such a manner will be apparent to the skilled artisan.

Referring to FIG. 1B, smokable material 20 is contained in a first circumscribing inner wrapping material 25, and a second outer wrapping material 27 circumscribes the first wrapping material. The first wrapping material 25 is formed into a circular shape such that a lap zone 74 including a suitable adhesive therebetween is formed. The second wrapping material includes a lap zone 76 including a suitable adhesive therebetween so as to form a secure outer wrapper. A cigarette rod having such a configuration can be provided by forming a cigarette rod using known techniques, and then wrapping the rod so formed with an outer wrapping material. Equipment for providing such a cigarette will be apparent to the skilled artisan.

Another embodiment of a cigarette of the present invention is shown in FIG. 3. The cigarette 10 is generally similar to the cigarette described with reference to FIG. 1, except that the tobacco rod 15 includes only one layer of circumscribing wrapping material 27 circumscribing the smokable material 20. The wrapping material 27 includes an additive package which is described in greater detail hereafter.

The smokable material employed in the manufacture of the tobacco rod can vary. For example, the smokable material of the cigarette can have the form of filler (e.g., tobacco cut filler). As used herein, the terms "filler" or "cut filler" are meant to include tobacco materials and other smokable materials which have a form suitable for use in the manufacture of tobacco rods for cigarettes. As such, filler can include smokable materials which are blended and are in a form ready for cigarette manufacture. The filler materials normally are employed in the form of strands or shreds as is common in conventional cigarette manufacture. For example, the cut filler material can be employed in the form of strands or shreds from sheet-like or "strip" materials which are cut into widths ranging from about 1/20 inch to about 1/60 inch, preferably from about 1/25 inch to about 1/35 inch. Generally, such strands or shreds have lengths which range from about 0.25 inch to about 3 inches.

Examples of suitable types of tobacco materials include flue-cured, Burley, Maryland or Oriental tobaccos, the rare or specialty tobaccos, and blends thereof. The tobacco material can be provided in the form of tobacco lamina; processed tobacco materials such as volume expanded or puffed tobacco, processed tobacco stems such as cut-rolled or cut-puffed stems, reconstituted tobacco materials; or blends thereof. Certain reconstituted tobacco materials are described in U.S. Pat. Nos. 4,987,906 to Young, et al. and 5,056,537 to Brown, et al.; in European Patent Application No. 419,733; and in U.S. Pat. application Ser. Nos. 647,329, filed Jan. 28, 1991; and 710,273, filed Jun. 4, 1991. Certain processed tobacco materials are described in U.S. Pat. Nos. 5,025,812 to Fagg, et al.; and 5,065,775 to Fagg. Certain blends are described in U.S Pat. Nos. 4,924,888 to Perfetti, et al.; 4,942,888 to Montoya, et al.; and 4,998,541 to Perfetti, et al. Preferably, the smokable material or blend of smokable materials consists essentially of to-

bacco filler material or consists only of tobacco filler material.

Smokable materials can be cased and top dressed as is conventionally performed during various stages of cigarette manufacture. As such, the smokable material, and particularly tobacco filler material, can include casing and/or top dressing components. For example, blend components such as flavoring agents and humectants, as well as other forms of tobacco (e.g., tobacco extracts), can be applied to the smokable material, as is commonly performed when cigarettes are manufactured. See, Leffingwell, et al., *Tobacco Flavoring For Smoking Products* (1972). Suitable flavoring agents and forms of tobacco include vanillin, tobacco extracts such as tobacco essences and tobacco aroma oils, cocoa, licorice, menthol, and the like. Flavor modifying agents such as levulinic acid can be applied to the smokable material (e.g., in amounts ranging from about 0.01 to about 2 percent, normally from about 0.1 to about 1 percent, preferably about 0.2 to about 0.6 percent, based on the dry weight of the smokable material). Such components conveniently are applied to the smokable material as casing and top dressing components. See, U.S. Pat. No. 4,830,028 to Lawson, et al.

Typically, the tobacco rod has a length which ranges from about 35 mm to about 85 mm, preferably about 40 to about 70 mm; and a circumference of about 17 mm to about 27 mm, preferably about 22.5 mm to about 25 mm. Short cigarette rods (i.e., having lengths from about 35 mm to about 50 mm) can be employed, particularly when smokable blends having a relatively high packing density are employed.

The packing densities of the blend of smokable materials contained within the wrapping materials can vary. Typical packing densities for tobacco rods of cigarettes of the present invention range from about 150 to about 300 mg/cm^3. Normally, packing densities of the tobacco rods range from about 200 to about 280 mg/cm^3.

The paper wrapping material which is further processed to provide a wrapping material of the present invention can vary. Such a wrapping material includes a cellulosic base web, and most preferably an essentially water insoluble (e.g., an inorganic) filler material. The cellulosic base web can be provided from flax fibers, wood pulp (e.g., hardwood pulp and softwood pulp), esparto fibers, sisal fibers, or other cellulosic material. Mixtures of 2 or more types of cellulosic materials can be employed. If desired, the cellulosic base web also can include tobacco parts or pieces (e.g., tobacco stem parts), extracted tobacco parts or pieces (e.g., tobacco pulp), or bleached tobacco parts or pieces. The filler material is an essentially water insoluble material, most preferably is an inorganic filler material, and can include particles of calcium carbonate, precipitated magnesium hydroxide gel, magnesium oxide particles, calcium sulfate fibers, agglomerated calcium carbonate particles, and the like. Exemplary filler materials suitable for use in paper manufacture are set forth in U.S. Pat. application Ser. No. 567,521, filed Aug. 15, 1990. Preferred wrapping materials include flax fiber/calcium carbonate, wood pulp/calcium carbonate, and flax fiber/wood pulp/calcium carbonate. Certain wrapping materials, particularly those incorporating calcium carbonate filler material, are essentially absent of magnesium-containing filler material (e.g., the wrapping material includes less than about 1, preferably less than about 0.5 percent of a magnesium-containing filler material, such as magnesium oxide or magnesium hydroxide). Methods for manufacturing suitable paper wrapping materials will be apparent to the skilled artisan.

The wrapping material which is further processed to provide the wrapping material of the present invention can have a wide range of compositions and properties. Typical paper wrapping materials include about 55 to about 100, often about 65 to about 95, and frequently about 70 to about 90 percent cellulosic material; and about 0 to about 45, often about 5 to about 35, and frequently about 10 to about 30 percent inorganic filler material; based on the dry weight of the paper. The basis weight of the paper can vary. Typical dry basis weights are at least about 15, and frequently are at least about 20 g/m^2; while typical basis weights do not exceed about 80, and frequently do not exceed about 60 g/m^2. The porosity of the paper can vary. Typical papers have inherent permeabilities which are less than about 300 CORESTA units, often are less than about 150 CORESTA units, frequently are less than about 75 CORESTA units, and usually are less than about 50 CORESTA units. By the term "inherent permeability" is meant the air flow porosity of the paper itself.

Exemplary wrapping materials are available as Ref. Nos. 419, 454, 455, 456, 719, 754, 854, 855 and 856 from Ecusta Corp.; P-3284-29, P-3284-28, P-3284-30, and P-3169-5B from Kimberly-Clark Corp. Other exemplary wrapping materials, though not preferred, are available as Ecusta Experimental Paper Nos. TOD 05504, TOD 05405, TOD 05273, TOD 05275, TOD 05375, TOD 05759, TOD 05721, TOD 05560, TOD 05505, TOD 05386, TOD 05390, TOD 05422, TOD 05387, TOD 05551, TOD 05151, TOD 05365, TOD 05992, TOD 05962, TOD 05963, TOD 05969, TOD 05943, TOD 06202 and TOD 06235 from Ecusta Corp. Preferably, such wrapping materials are employed as the outer wrapping material of those tobacco rods having two layers of wrapping materials; however, such wrapping materials also can be employed as inner wrapping materials of those tobacco rods having two layers of wrapping materials.

The additive package includes at least one water soluble alkali earth metal ion component. Examples of such a component are calcium ions, magnesium ions, and mixtures of calcium and magnesium ions. Typically, such a component is provided as at least one water soluble salt. Salts of alkali earth metal ion components and organic anion components are particularly preferred, although salts of alkali earth metal ion components and inorganic anion components also can be employed. Exemplary salts include magnesium acetate, calcium acetate, magnesium propionate, calcium propionate, magnesium formate, calcium formate, magnesium chloride, calcium chloride, magnesium nitrate, calcium nitrate, and the like. Mixtures of 2 or more salts can be employed.

The additive package most preferably includes at least one water soluble alkali metal ion component. Examples of such a component are sodium ions and potassium ions, and mixtures of sodium and potassium ions. Typically, such a component is provided as at least one water soluble salt. Salts of alkali metal ion components and organic anion components, as well as salts of alkali metal ion components and inorganic anion components, can be employed. Exemplary salts include potassium chloride, sodium citrate, sodium chloride, sodium phosphate, potassium nitrate, potassium lactate, potassium gluconate, sodium nitrate, potassium acetate, sodium acetate, potassium borate, sodium borate, potas-

sium malate, potassium citrate, potassium succinate, potassium propionate, and the like. Preferably, potassium ion components are particularly preferred. Mixtures of 2 or more salts can be employed.

The additive package includes at least one water soluble organic anion component. Particularly desirable are those organic anions that, when present in a treated wrapping material as calcium or magnesium salts, have the capability to thermally decompose at those temperatures experienced during the smoking period of a cigarette to form a calcium carbonate or magnesium oxide, respectively. Exemplary organic anions include acetate, propionate, formate and lactate ions. Mixtures of different organic anions can be employed.

The additive package preferably includes at least one water soluble inorganic anion component. Exemplary inorganic anions include chloride, sulfate, nitrate, phosphate and borate ions. Mixtures of different inorganic anions can be employed.

The manner in which the additive package is applied to, incorporated into, or otherwise provided in intimate contact with the paper can vary. Most preferably, the additive package is incorporated into the paper after the paper manufacturing process (i.e., the paper is post-treated with the additive package). In particular, the additive package can be applied to manufactured paper using size press techniques, spraying techniques, painting techniques, rotogravure techniques, printing techniques, flood roller techniques, immersion techniques, or the like. Such techniques will be apparent to the skilled artisan. The additive package can be applied to one or both sides of the paper in a patterned manner; applied uniformly to one or both sides of the paper; or incorporated essentially throughout the paper, preferably in a uniform manner. Uniform distribution of components throughout the paper is desirable, in order that the additive package can provide a sealant character to the paper so as to provide desirable ash forming properties. The components of the additive package can be incorporated into the paper simultaneously or individually at different processing stages. Preferably, a very concentrated aqueous solution (e.g., a near saturated solution) of at least one salt is applied to the paper. Normally, the components of the additive package are dissolved in water, applied as an aqueous solution to the paper, and then the paper is dried to provide the component salts in intimate contact with the resulting treated paper. Alternatively, an organic acid (e.g., acetic acid) can be combined with an alkali earth metal ion-containing salt (e.g., magnesium sulfate) in water for application to the paper. A mixture of salts which would otherwise form precipitates if mixed together in water can be applied to the paper individually as components of separate aqueous solutions. As one example, an aqueous solution of calcium acetate, magnesium propionate and potassium chloride can be applied to the paper; the paper can be dried; then an aqueous solution of potassium malate and potassium citrate can be applied to (e.g., sprayed onto) the paper; and the paper can be dried. As another example, an aqueous solution of potassium carbonate can be applied to the paper; the paper can be dried; then an aqueous solution of calcium acetate and calcium chloride can be applied to the paper; and the paper can be dried. As yet another example, an aqueous solution of calcium acetate can be applied to the paper, the paper can be dried; then an aqueous solution of potassium carbonate can be applied to the paper; the paper can be dried; then an aqueous solution of calcium acetate and calcium chloride can be applied to the paper; and the paper can be dried. Treated papers can be dried in a variety of ways (e.g., by air drying techniques, or by conductive or convective heating techniques, such as using drum dryers or tunnel dryers).

The amount of additive package remaining in intimate contact with the treated or finished wrapping material can vary. The amount of additive package within the finished paper typically is such that the package provides at least 5, normally at least about 10, often at least about 15, and frequently at least about 20 percent of the dry weight of the finished pap However, the amount of additive package within the finished paper normally provides up to about 40, often up to about 35, and frequently up to about 30 percent of the dry weight of the finished paper. Relatively high levels of additive package (e.g., about 30 percent or more, based on the dry weight of the finished paper) can be employed when the level of inorganic filler material of the paper is relatively low (e.g., less than about 10 percent, based on the weight of the paper prior to treatment). Wrapping materials treated with the additive package according to the present invention typically exhibit a significant increase in basis weight as compared to the untreated wrapping material. Preferably, the majority by weight of the components of the additive package remain in water soluble form (i.e., as water soluble salts) while those components are in intimate contact with the wrapping material, during the useful lifetime of the wrapping material. For example, more than about 50, preferably more than about 75, and most preferably more than about 90 weight percent of the additive package remains in a water soluble salt form during the useful lifetime of the wrapping material.

The amount of individual components of the additive package relative to one another can vary. A highly preferred additive package includes (i) optional alkali metal ions and (ii) alkali earth metal ions, such that the ratio of equivalents of (i) to (ii) ranges from about 0 to about 1.2, typically about 0.05 to about 1, often about 0.1 to about 0.7, and frequently about 0.2 to about 0.5. A highly preferred additive package also includes (iii) optional inorganic anions and (iv) organic anions, such that the ratio of equivalents of (iii) to (iv) ranges from about 0 to about 1, typically about 0.05 to about 0.7, often about 0.1 to about 0.5, and frequently about 0.1 to about 0.3. In addition, for an additive package, the total number of equivalents of (i) plus (ii) equals the total number of equivalents of (iii) plus (iv). Although the additive package can be absent of, or essentially absent of, alkali metal ion and/or inorganic anion components (i.e., those components are optional), it is highly preferred that one or both of those components be present as part of the additive package. For preferred additive packages, the ratio of equivalents of (i) to (ii) is less than about 0.5, and most preferably is less than about 0.4; and the ratio of equivalents of (iii) to (iv) is less than about 0.5, and most preferably less than about 0.4.

The various components of the additive package provide various characteristics to the wrapping material to which the package is applied. Certain components of the package can act as ash formers, and hence provide for a good quality, uniform ash. Certain components can act as burn chemicals (e.g., as burn inhibitors, burn retardants or burn accelerators) in order to control the burn rate of the cigarette, and hence provide the desired puff count and provide a cigarette which exhib-

its a propensity to not self-extinguish. Certain components can act as ash conditioners or ash sealers.

The wrapping material having the additive package in intimate contact therewith most preferably is a cigarette wrapping material having a moderate to low inherent air permeability value. For example, such wrapping materials having the additive package incorporated therein have inherent air permeabilities (i.e., the air flow porosity of the treated paper itself) of less than about 30 CORESTA units, normally less than about 25 CORESTA units, generally less than about 20 CORESTA units, often less than about 15 CORESTA units, and frequently less than about 10 CORESTA units.

The wrapping material having the additive package in intimate contact therewith, and in particular a wrapping material having a relatively low inherent permeability, can be processed in order to have a relatively high net permeability (e.g., a net permeability above about 40, and preferably above about 50 CORESTA units). By the term "net permeability" is meant the air flow porosity of the wrapping material as used in manufacturing the tobacco rod. Typically, the air permeability is provided to the wrapping material using micro laser, mechanical or electrostatic perforation techniques. During micro laser and electrostatic perforation operations, it is most desirable that care be taken to maintain the desired color and opacity of the paper. For example, it is most desirable to minimize or avoid an unsightly "browning" or singeing of the paper. For example, such wrapping materials having low inherent permeabilities can be perforated using conventional electrostatic perforating techniques (e.g., to provide individual perforations comparable in size to conventional electrostatically provided perforations) to obtain a wrapping material having a net porosity of from about 50 to about 225 CORESTA units, preferably from about 80 to about 180 units, more preferably from about 90 to about 120 CORESTA units.

The sizes of the individual perforations which provide for the high net permeabilities to such wrapping materials generally are such that the perforations are larger than the pores which are present in the naturally occurring paper wrapping material (i.e., which provide the inherent permeability to the paper). For aesthetic purposes, the individual perforations preferably are small enough to not be unsightly. For example, the perforations are not particularly noticeable, and in most instances are barely visible to the naked eye.

If desired, flavoring agents and/or flavor and aroma precursors (e.g., vanillin glucoside and/or ethyl vanillin glucoside) also can be incorporated into the paper wrapping material having the additive package incorporated therein. See, U.S. Pat. No. 4,941,486 to Dube, et al., which is incorporated herein by reference. Other additives, such as acids, can be applied to the wrapping material in combination with or in addition to the additive package. Exemplary acids include malic acid, levulinic acid, boric acid, lactic acid, and the like. Certain acids can be incorporated into the wrapping material by combining a slight excess of acid with a corresponding base when the additive package is being formulated.

The inner wrapping material of certain tobacco rods of certain cigarettes of the present invention is a paper, and most preferably is a paper which comprises tobacco material. A certain amount of inorganic filler material (e.g., calcium carbonate) and/or a water soluble salt (e.g., potassium citrate) most preferably is incorporated into the inner wrapping material. The inner wrapping material also can include a carbonaceous material. The inherent permeability of the inner wrapping material can vary, but usually is higher than the inherent permeability of the outer wrapping material, and frequently is quite high relative to the outer wrapping material. Normally, the ultimate inherent permeability provided by the combined wrapping materials is slightly less than that inherent permeability of the outer wrapping material; however, effects of the inner wrapping material towards lowering the ultimate inherent permeability of the combined wrapping materials are less in instances in which the differences between the inherent permeabilities of the inner and outer wrapping materials are relatively great. Generally, the inherent permeability of the inner wrapping material is above about 10 CORESTA units, often above about 50 CORESTA units, and frequently is above about 100 CORESTA units, although the permeability of that wrapping material can approach 1,000 CORESTA units. The inner wrapping material can be perforated (e.g., electrostatically perforated) to provide the desired net permeability.

Various inner wrapping materials can be employed. One type of inner wrapping material is described in U.S. Pat. application Ser. No. 833,193 filed Feb. 6, 1992. Certain other tobacco-containing inner wrapping materials are described in U.S. Pat. application Ser. Nos. 661,747, filed Feb. 27, 1991, and 759,266, filed Oct. 3, 1991, which are incorporated herein by reference. One wrapping material is available as P-2540-94-A from Kimberly-Clark Corp.; which is a paper containing about 29 weight percent particles of activated charcoal provided from coconut hulls and about 71 weight percent tobacco parts, and having a permeability of about 250 CORESTA units. Another wrapping material is available as P-2540-94-C from Kimberly-Clark Corp.; which is a paper containing about 40 weight percent particles of activated charcoal provided from coconut hulls and about 60 weight percent tobacco parts, and having a permeability of about 350 CORESTA units. Another wrapping material is available as P-2540-94-D from Kimberly-Clark Corp.; which is a paper containing about 50 weight percent particles of activated charcoal provided from coconut hulls and about 50 weight percent tobacco parts, and having a permeability of about 380 CORESTA units. Another wrapping material is available as P-2540-136-C from Kimberly-Clark Corp.; which is a paper made from wood pulp, flue-cured and Burley tobacco stems and carbonized hardwood particles, and has a basis weight of about 47 g/m^2 and an inherent permeability of about 14 CORESTA units. Another wrapping material is available as P-3122-4-4 from Kimberly-Clark Corp.; which is a paper made from about 20 weight percent wood pulp, about 30 weight percent Turkish tobacco strip, about 30 weight percent "American blend" in cut filler form and about 20 weight percent calcium carbonate particles, and is electrostatically perforated to a net permeability of about 150 CORESTA units. Another wrapping material is available as P-2831-189-AA4 from Kimberly-Clark Corp.; which is a paper made from 20 weight percent wood pulp, about 30 weight percent Turkish tobacco strip, about 30 weight percent "American blend" in cut filler form and about 20 weight percent calcium carbonate particles, and has a basis weight of about 60 g/mand an inherent permeability of about 125 CORESTA units. Another wrapping is available as P-3284-11 from Kimberly-Clark Corp., which is a paper made from 25 weight percent wood pulp, about 66

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weight percent Turkish tobacco strip and about 9 weight percent calcium carbonate particles, and has a basis weight of about 60 g/m^2 and an inherent permeability of about 50 CORESTA units. Other wrapping materials include carbonaceous material, wood pulp and tobacco stem parts; have porosities between about 60 and about 150 CORESTA units; have basis weights between about 45 g/m^2 and about 70 g/m^2; and are available as P-2540-107-A, P-2540-107-B, P-2540-107-C and P-2540-107-D from Kimberly-Clark Corp. Other materials are available as P-2249-115, P-2674-157, P-2540-155, P-2540-136-D, P-2540-136-E, P-2540-152, P-2540-150, P-2540-157, P-2540-151, P-2540-156, P-2831-197-A10, P-2540-94-A, P-144-KC-G, P-144-RB, P-144-KCL, P-144-SN20, P-144-BHC, P-2674-157-A5116, P-2674-157-A5116, P-2831-130, P-2831-22-1, P-2831-23-3, P-1976-25-1, P-1976-25-2, P-2540-191, P-2540-192, P-2540-193, P-2540-194, P-2540-195, P-2540-196, P-1976-25-3, P-2831-189-B1-6606, P-3284-14, P-3284-14-1, P-3284-14-2, P-3284-14-3, P-3284-196, P-2831-189-B2-6608 and P-2831-189-B3-6609 from Kimberly-Clark Corp. Although less preferred from a manufacturing standpoint, the inner wrap also can be a reconstituted tobacco material of the type described in U.S. Pat. Nos. 4,962,774 to Thomasson, et al. and 4,987,906 to Young, et al. and U.S. Pat. application Ser. No. 710,273, filed Jun. 4, 1991.

The most preferred inner wrapping materials are tobacco containing papers. Tobacco containing papers are made from tobacco parts (e.g., tobacco stems, tobacco fines, pieces of tobacco stems, tobacco dust, tobacco cut filler, tobacco strip, tobacco leaf, processed tobacco stems, tobacco scrap, extracted tobacco pulp, and/or tobacco extracts). Preferred tobacco containing papers include the cellulosic portion of the tobacco material, and also can include one or more tobacco extracts. As such, preferred tobacco containing papers incorporate tobacco as a cellulosic component. The inner wrapping materials also can have cellulosic materials (e.g., wood pulp), as well as additive water soluble salts and additive inorganic fillers (e.g., calcium carbonate and/or magnesium hydroxide) incorporated therein. Methods for manufacturing such papers will be apparent to the skilled artisan.

Typically, the filter element has a length which ranges from about 15 mm to about 40 mm, preferably about 20 mm to about 35; and a circumference of about 17 mm to about 27 mm, preferably about 22 mm to about 25 mm. The filter element can have a wide range of filtration efficiencies. The filter element can have one segment of filter material, two or more longitudinally positioned segments, or other configurations. Exemplary filter materials include cellulose acetate tow, cellulose acetate web, non-woven polypropylene web and non-woven polyester web. The filter material can be plasticized (e.g., using triacetin). Exemplary filter elements are described in U.S. Pat. application Ser. Nos. 661,747, filed Feb. 27, 1991, and 759,266, filed Oct. 3, 1991, which are incorporated herein by reference.

Typically, the tipping material circumscribes the filter element and an adjacent region of the tobacco rod such that the tipping material extends about 3 mm to about 6 mm along the length of the tobacco rod. Typically, the tipping material is a conventional paper tipping material and is adhesively secured to the filter element and the adjacent region of the tobacco rod. The tipping material can have a permeability which can vary. For example, the tipping material can be essentially air impermeable, air permeable, or be treated (e.g., by mechanical or laser perforation techniques) so as to have a region of perforations, openings or vents thereby providing a means for providing air dilution to the cigarette. The total surface area of the perforations and the positioning of the perforations along the periphery of the cigarette can be varied in order to control the performance characteristics of the cigarette.

For air diluted or ventilated cigarettes of the present invention, the amount of air dilution can vary. Often, the amount of air dilution for an air diluted cigarette is greater than about 10 percent, and frequently greater than about 25 percent. The upper limit of air dilution for a cigarette typically is less than about 75 percent, more frequently less than about 65 percent.

Cigarettes of the present invention exhibit a desirably high resistance to draw. For example, cigarettes of this invention exhibit a pressure drop of between about 50 and about 200 mm water pressure drop at 17.5 cc/sec. air flow. Typically, pressure drop values of cigarettes are measured using a Filtrona Filter Test Station (CTS Series) available from Filtrona Instruments and Automation Ltd. Cigarettes of this invention preferably exhibit resistance to draw values of about 70 to about 180, more preferably about 80 to about 150 mm water pressure drop at 17.5 cc/sec. air flow.

Cigarettes of the present invention, when smoked, generally yield less than about 20 mg, preferably less than about 10 mg of sidestream "tar" per cigarette, as determined using the apparatus and techniques described by Proctor, et al., Analyst, Vol. 113, p. 1509 (1988). Such cigarettes normally provide more than about 6 puffs, preferably more than about 8 puffs per cigarette when smoked under FTC conditions. FTC conditions consist of 35 ml puffs of 2 second duration separated by 58 seconds of smolder. Normally, cigarettes of the present invention provide less than about 15 puffs, and often less than about 12 puffs, when smoked under FTC conditions. Normally, cigarettes of the present invention yield less than about 2 mg, preferably less than about 1.5 mg, and most preferably less than about 1 mg of sidestream "tar" per 1 minute puff cycle period, when smoked under FTC conditions.

A cigarette of the present invention, when smoked, is capable of yielding an ash and firecone which are acceptable. The preferred ash is not overly dark in color, is not easily dislodged from the cigarette, and is not flaky. The firecone is of acceptable length, is not overly cohesive, and is not overly fragile (i.e., the ash maintains its integrity). However, preferred cigarettes yield a fairly cohesive ash having a minimal amount of fractures and fissures, and yield a fairly continuous phase ash as provided by the wrapping material of the present invention. Preferred cigarettes yield an ash which exhibits a propensity to "fuse" to the ash of the tobacco column, and hence exhibit a tendency to be supported by the tobacco column ash.

Cigarettes of the present invention exhibit a tendency to maintain smolder under static burning conditions (i.e., without puffing after the lighting puff) and do not exhibit a propensity to self-extinguish. Much preferred cigarettes maintain smolder for at least about 3 minutes, more preferably at least about 5 minutes, and often at least about 7 minutes, without self-extinguishing. Preferred cigarettes are such that at least about one third of the burnable length of the tobacco rod, often at least about one half of the burnable length of the tobacco rod, and frequently the total burnable length of the

tobacco rod is consumed during static burning conditions without self-extinguishing.

Cigarettes of the present invention burn at an acceptable rate during smoking, particularly under free smolder (i.e., static burning) conditions. Typical cigarettes of the present invention, and particularly those cigarettes having a circumference of about 24 mm to about 25 mm, exhibit a static tobacco rod linear burn rate of less than about 6 mm/min.

Cigarettes of the present invention generally provide FTC "tar" yields in the range from about 2 to about 14 mg/cigarette, although other "tar" yields are possible. Typical FTC carbon monoxide to FTC "tar" ratios for such cigarettes are less than about 2, and sometimes are less than about 1.8. Cigarettes of the present invention exhibit desirable organoleptic properties. Cigarettes having magnesium ions as a component of the additive package have a tendency to provide mainstream smoke having relatively low sour flavor characteristics, tend to produce a white ash, and tend to produce a narrow char line having a desirable color and shape. Cigarettes having calcium ions as component of additive package have a tendency to provide mainstream smoke which does not exhibit an overly chalky flavor.

The following examples are provided in order to further illustrate the invention but should not be construed as limiting the scope thereof. Unless otherwise noted, all parts and percentages are by weight.

EXAMPLE 1

Cigarettes substantially as shown in FIG. 1 are prepared as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm, and include a tobacco rod having a length of 57 mm and a filter element having a length of about 27 mm. The tobacco rod includes a smokable blend circumscribed by a layer of wrapping material which is in turn circumscribed by a second or outer wrapping material. Each filter element is available as TSS 4198 from FIL International, Ltd. Each filter element is attached to each tobacco rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and about a 4 mm length of the tobacco rod in the region adjacent the filter element. The filter elements are ventilated to about 45 percent air dilution by providing a ring of mechanical perforations around the paper wrapping materials of the filter element about 13 mm from the extreme mouthend of the cigarette.

The smokable blend of the tobacco rod consists of tobacco material which has been cased with a casing mixture. The tobacco material has the form of a so-called "American blend," and includes flue-cured, Burley and Oriental tobaccos as well as reconstituted tobacco from a paper-making process, and volume expanded flue-cured and Burley tobaccos. The blend of tobacco materials is cased using a mixture of glycerin, water and flavors. The blend is in the form of strands or shreds cut at about 25 cuts per inch (i.e., in cut filler form) and is equilibrated to a moisture level of about 12.5 percent. Each cigarette rod includes about 650 mg tobacco material.

The second or outer wrap is a treated paper. The paper which is treated comprises about 12 parts wood pulp, about 1 part flax fibers and about 6 parts calcium carbonate filler prior to treatment. The paper includes less than 1 percent of a mixture of sodium citrate and potassium citrate prior to treatment. The paper which is treated is available as Ref. No. 456 from Ecusta Corp. The paper has a measured basis weight of about 24.7 g/m^2, and a measured porosity of about 22 CORESTA units. The paper is treated with an aqueous solution comprising about 20 parts calcium acetate, about 3 parts potassium acetate, about 3 parts potassium chloride and about 74 parts water. The solution is applied to the paper wrap by immersing the wrap in the solution at ambient temperature so as to saturate that paper with the solution. The paper is removed from the solution, pressed to remove excess solution, dried at about 80° C. to about 90° C. on a curved top sheet dryer, and conditioned under ambient conditions for about 4 hours. After conditioning, the paper exhibits a basis weight of 33 g/m^2 and a porosity of 7.9 CORESTA units. The final outer wrap includes about 75 parts calcium carbonate, wood pulp and flax fiber; and about 25 parts of a mixture of calcium, acetate, potassium and chloride ions provided by the additive package.

The first or inner cigarette paper wrap is available as P-2831-130 from Kimberly-Clark Corp. The paper wrap includes tobacco parts, wood pulp and calcium carbonate particles. The inner paper wrap is absent of added burn chemical in the form of added water soluble salt. The paper is light brown in color, has a somewhat rough surface texture, and exhibits an inherent permeability of about 50 CORESTA units.

The tobacco rod is such that the inner wrap circumscribes the smokable blend and the outer wrap circumscribes the inner wrap. The inner and outer wraps directly contact one another (i.e., the inner surface of the outer wrap contacts the outer surface of the inner wrap).

Exemplary cigarettes are made using the treated outer wrap and the inner wrap. Comparison cigarettes are made using untreated Ref. No. 456 paper and the inner wrap.

The cigarettes are employed by burning the tobacco rod such that the blend of smokable material within the paper wrapper burns to yield smoke. When employed, the exemplary cigarettes yield very low levels of visible sidestream smoke and sustain smolder under static burning conditions after the lighting puff such that the total burnable length of the tobacco rod is consumed (i.e., the cigarette does not self-extinguish).

The cigarettes are smoked under FTC smoking conditions, and the exemplary cigarette yield 11 puffs, while the comparison cigarette yields 10 puffs. The cigarettes are also tested for sidestream smoke production by optical indication of smoke collected in a box during smoking of cigarettes under FTC smoking conditions. Sidestream absorbance values are determined after 6 puffs using the method described in U.S. Pat. No. 4,589,775 to Milhouse, Jr. et al. The sidestream absorbance value for the comparison cigarette is 0.3696, while that for the exemplary cigarette is 0.1864.

EXAMPLE 2

Cigarettes are provided essentially as described in Example 1; however, the outer wrap is treated with an aqueous solution comprising about 30 parts calcium acetate, about 2 parts potassium acetate, about 3 parts potassium chloride and about 86 parts water using techniques essentially as described in Example 1. The treated outer wrap exhibits a basis weight of about 32.8 g/m^2 and a porosity of about 10 CORESTA units. The final outer wrap includes about 75 parts calcium carbonate, flax and wood pulp; and about 25 parts of the addi-

tive package of calcium, potassium acetate, and chloride ions provided by the additive package of calcium acetate, potassium acetate and potassium chloride.

The cigarettes are smoked and tested as described in Example 1, and yield 10.7 puffs and yield a sidestream absorbance value of 0.1972.

EXAMPLE 3

Cigarettes are provided essentially as described in Example 1; however, the inner wrap is available as P-3284-14 from Kimberly-Clark Corp., and the outer wrap is provided as follows:

A paper wrapping material comprises calcium carbonate and wood pulp, and is available as P-3284-28 from Kimberly-Clark Corp. The paper is treated with an aqueous solution comprising about 25 parts calcium acetate, about 3 parts potassium acetate, and 3 parts potassium chloride and about 86 parts water, using techniques essentially as described in Example 1. The treated outer wrap includes about 22 parts calcium, potassium, acetate and chloride ions provided by the additive package.

EXAMPLE 4

Cigarettes are provided essentially as described in Example 3; however, the outer wrap is treated with an aqueous solution comprising about 3 parts potassium acetate, about 3 parts potassium chloride, about 34.5 parts magnesium acetate tetrahydrate and about 85 parts water.

EXAMPLE 5

Cigarettes are provided essentially as described in Example 3; however, the outer wrap is treated with an aqueous solution comprising about 10 parts calcium acetate, about 20 parts magnesium acetate tetrahydrate, about 3 parts potassium acetate, about 3 parts potassium chloride and about 85 parts water.

EXAMPLE 6

Cigarettes are provided essentially as described in Example 3; however, the outer wrap is treated with an aqueous solution comprising about 12 parts calcium acetate, about 18 parts magnesium acetate tetrahydrate, about 3 parts potassium acetate, about 3 parts potassium chloride and about 85 parts water.

EXAMPLE 7

Cigarettes are provided essentially as described in Example 3; however, the outer wrap is treated with an aqueous solution comprising about 13 parts calcium acetate, about 15 parts magnesium acetate tetrahydrate, about 3 parts potassium chloride, about 3 parts potassium chloride and about 85 parts water.

EXAMPLE 8

Cigarettes are provided generally as described in Example 1; however, the inner wrap is available as P-3284-14-3 from Kimberly-Clark Corp., and the outer wrap is provided as follows:

A solution comprising about 29 parts calcium acetate, about 3.5 parts potassium acetate, about 3.5 parts potassium chloride and about 109 parts of water is applied to a paper wrapping material available as Ref. No. 456 from Ecusta Corp. The solution is applied to the paper as a coating using an 85 Quad Cylinder on a Faustel Laminator. The treated, finished paper includes about 19 percent calcium, potassium, chloride and acetate ions provided by the additive package.

EXAMPLE 9

Cigarettes are provided as described in Example 8; however, the outer wrap is treated with an aqueous solution comprising 25.8 parts magnesium acetate tetrahydrate, 9.4 parts calcium acetate, 4.2 parts potassium acetate, about 4.2 parts potassium chloride and about 102 parts water. The treated, finished paper includes about 18 percent calcium, magnesium, potassium, chloride and acetate ions provided by the additive package.

EXAMPLE 10

Cigarettes are provided essentially as described in Example 3; however, the outer wrap is provided as follows:

A paper wrapping material available as P-3169-5B from Kimberly-Clark Corp. includes wood pulp and a very low level of inorganic filler material (e.g., less than about 5 percent calcium carbonate filler material). The paper exhibits a measured basis weight of about 19 g/m^2 and a porosity of about 28 CORESTA units. The paper is treated with an aqueous solution comprising about 10 parts calcium acetate, and about 20 parts magnesium acetate tetrahydrate, about 3 parts potassium acetate, about 3 parts potassium chloride and about 85 parts water. The treated outer wrap includes about 20 parts calcium, magnesium, potassium, chloride and acetate ions provided by the additive package. The treated paper is dried, and exhibits a basis weight of about 22 g/m^2 and a porosity of about 14 CORESTA units.

EXAMPLE 11

Cigarettes are provided essentially as described in Example 3; except that the outer wrap is provided as follows:

A paper wrapping material available as TOD 06235 from Ecusta Corp. is treated with an aqueous solution comprising about 5 parts calcium acetate, about 8 parts magnesium acetate tetrahydrate, about 2 parts potassium acetate, about 3 parts potassium chloride and about 85 g water, using techniques essentially as described in Example 1. The treated outer wrap includes about 10 parts calcium, magnesium, potassium, acetate and chloride ions provided by the additive package.

EXAMPLE 12

Cigarettes are provided essentially as described in Example 9; however, the inner wrap is available as TOD 06235 from Ecusta Corp.

EXAMPLE 13

Cigarettes are provided essentially as described in Example 9; however, the inner wrap is provided as follows:

A paper wrapping material available as TOD 06235 from Ecusta Corp. is treated with an aqueous solution comprising about 5 parts calcium acetate, about 8 parts magnesium acetate tetrahydrate, about 2 parts potassium acetate, about 3 parts potassium chloride and about 74 parts water, using techniques essentially as described in Example 1. The treated inner wrap includes about 10 parts calcium, magnesium, potassium, acetate and chloride ions provided by the additive package.

EXAMPLE 14

A paper available as P-3122-14 from Kimberly-Clark Corp. includes about 30 parts calcium chloride, and that paper is treated with an aqueous solution comprising 15 parts potassium carbonate and about 85 parts water using a flooded nip roller technique. The treated paper is dried at about 80° C. to about 90° C. using a curved top sheet dryer. The treated paper includes significant inclusion of calcium carbonate, and the calcium carbonate is distributed to a greater degree towards the "felt side" of the paper.

EXAMPLE 15

A cigarette substantially as shown in FIG. 1 and having only one layer of circumscribing wrapping material surrounding the smokable material is provided essentially as described in Example 1. The wrapping material is available as Ref. No. 456 from Ecusta Corp. and is treated as described in Example 1 by immersing that wrapping material into an aqueous solution comprising about 12 parts calcium acetate, about 2 parts potassium acetate and about 86 parts water. The resulting treated paper includes about 85.5 parts calcium carbonate, wood pulp and flax fiber; and about 14.5 parts of a mixture of calcium, acetate and potassium ions provided by the additive package.

The exemplary cigarette having the treated wrapping material and a comparison cigarette (i.e., a similar cigarette including untreated Ref. No. 456 paper) are treated for sidestream smoke production using the techniques described in Example 1. The sidestream smoke absorbance value for the comparison cigarette is 0.6716, while that for the exemplary cigarette is 0.5243.

What is claimed is:

1. A cigarette comprising a rod of smokable material contained in a circumscribing paper wrapping material in intimate contact with an additive package, the paper wrapping material comprising a cellulosic base web and an additive package including water soluble components, which additive package
   (a) provides about 5 to about 40 percent of that paper wrapping material on a dry weight basis; and
   (b) includes (i) alkali metal ions and (ii) alkali earth metal ions, such that the ratio of equivalents of (i) to (ii) ranges from about 0.05 to about 1; and (iii) inorganic anions and (iv) organic anions, such that the ratio of equivalents of (iii) to (iv) ranges from about 0.05 to about 0.7; the equivalents of components (i) plus (ii) being equal to the equivalents of components (iii) plus (iv).

2. The cigarette of claim 1 wherein the paper wrapping material includes a cellulosic base web and at least one inorganic filler material.

3. The cigarette of claim 2 wherein the cellulosic base web comprises wood pulp and flax fibers.

4. The cigarette of claim 2 wherein the inorganic filler material includes calcium carbonate.

5. The cigarette of claim 2 wherein the paper wrapping material, absent of the additive package, includes about 65 to about 95 percent cellulosic material and about 5 to about 35 percent inorganic filler material, on a dry weight basis.

6. The cigarette of claim 2 wherein the organic filler material consists essentially of calcium carbonate.

7. The cigarette of claim 4 wherein the additive package includes magnesium ions.

8. The cigarette of claim 1 or 2 wherein the additive package includes a mixture of magnesium ions and calcium ions.

9. The cigarette of claim 8 wherein the additive package includes potassium ions.

10. The cigarette of claim 1 or 2 wherein the additive package includes potassium ions.

11. The cigarette of claim 1 or 2 wherein the additive package includes chloride ions.

12. The cigarette of claim 1 or 2 wherein the additive package includes acetate ions.

13. The cigarette of claim 1 or 2 wherein more than 75 weight percent of the additive package in intimate contact with the paper wrapping material has a water soluble form.

14. The cigarette of claim 1 or 2 wherein the organic anions are acetate ions, propionate ions, formate ions or lactate ions.

15. The cigarette of claim 1 or 2 wherein the additive package includes calcium, potassium, acetate and chloride ions.

16. The cigarette of claim 1 or 2 wherein the inorganic anions are chloride ions, sulfate ions, nitrate ions, phosphate ions or borate ions.

17. The cigarette of claim 1 or 2 wherein alkali earth metal ions include calcium ions.

18. The cigarette of claim 1 or 2 wherein the paper wrapping material comprising the additive package exhibits an inherent porosity of less than about 30 CORESTA units.

19. The cigarette of claim 1 or 2 wherein the additive package provides about 10 to about 35 percent of the dry weight of the paper wrapping material.

20. The cigarette of claim 1 or 2 wherein the additive package provides about 15 to about 30 percent of the dry weight of the paper wrapping material.

21. The cigarette of claim 1 or 2 wherein the additive package is such that the ratio of equivalents of (i) to (ii) ranges from about 0.2 to about 0.5; and the ratio of equivalents of (iii) to (iv) ranges from about 0.1 to about 0.3.

22. The cigarette of claim 1 or 2 wherein the smokable material is circumscribed by a further wrapping material, and the further wrapping material is circumscribed by the paper wrapping material.

23. The cigarette of claim 22 wherein the further wrapping material includes cellulosic material and at least one inorganic filler material.

24. The cigarette of claim 23 wherein the inorganic filler material of the further wrapping material includes calcium carbonate.

25. The cigarette of claim 23 wherein the inorganic filler material of the further wrapping material includes magnesium hydroxide.

26. The cigarette of claim 22 wherein the paper wrapping material includes wood pulp as a cellulosic base web component, and calcium carbonate as an inorganic filler material component.

27. The cigarette of claim 22 wherein the paper wrapping material comprises at least one inorganic filler material which includes calcium carbonate.

28. The cigarette of claim 22 wherein the additive package provides about 10 to about 35 percent of the paper wrapping material on a dry weight basis.

29. The cigarette of claim 22 wherein the additive package provides about 15 to about 30 percent of the paper wrapping material on a dry weight basis.

30. The cigarette of claim 22 wherein the additive package is such that the ratio of equivalents of (i) to (ii) ranges from about 0.2 to about 0.5, and the ratio of equivalents of (iii) to (iv) ranges from about 0.1 to about 0.3

31. The cigarette comprising a rod of smokable material contained in a circumscribing paper wrapping material in intimate contact with an additive package, the paper wrapping material comprising a cellulosic base web and an additive package including water soluble components, which additive package

(a) provides about 5 to about 40 percent of that paper wrapping material on a dry weight basis; and

(b) includes (i) alkali earth metal ions; and (ii) inorganic anions and (iii) organic anions, such that the ratio of equivalents of (ii) to (iii) ranges from about 0.05 to about 0.7; the equivalents of component (i) being equal to the equivalents of components (ii) plus (iii).

32. The cigarette of claim 31 wherein the paper wrapping material includes a cellulosic base web and at least one inorganic filler material.

33. The cigarette of claim 32 wherein the cellulosic base web comprises wood pulp and flax fibers.

34. The cigarette of claim 32 wherein the inorganic filler material includes calcium carbonate.

35. The cigarette of claim 32 wherein the paper wrapping material, absent of the additive package, includes about 65 to about 95 percent cellulosic material and about 5 to about 35 percent inorganic filler material, on a dry weight basis.

36. The cigarette of claim 32 wherein the organic filler material consists essentially of calcium carbonate.

37. The cigarette of claim 31 or 32 wherein more than 75 weight percent of the additive package in intimate contact with the paper wrapping material has a water soluble form.

38. The cigarette of claim 31 or 32 wherein the organic anions are acetate ions, propionate ions, formate ions or lactate ions.

39. The cigarette of claim 31 or 32 wherein the inorganic anions are chloride ions, sulfate ions, nitrate ions, phosphate ions or borate ions.

40. The cigarette of claim 31 or 32 wherein alkali earth metal ions include calcium ions.

41. The cigarette of claim 31 or 32 wherein the additive package includes a mixture of magnesium ions and calcium ions.

42. The cigarette of claim 31 or 32 wherein the additive package includes chloride ions.

43. The cigarette of claim 31 or 32 wherein the additive package includes acetate ions.

44. The cigarette of claim 31 or 32 wherein the paper wrapping material comprising the additive package exhibits an inherent porosity of less than about 30 CORESTA units.

45. The cigarette of claim 31 or 32 wherein the additive package provides about 10 to about 35 percent of the dry weight of the paper wrapping material.

46. The cigarette of claim 31 or 32 wherein the additive package provides about 15 to about 30 percent of the dry weight of the paper wrapping material.

47. The cigarette of claim 31 or 32 wherein the additive package is such that the ratio of equivalents of (ii) to (iii) ranges from about 0.1 to about 0.3.

48. The cigarette of claim 31 or 32 wherein the smokable material is circumscribed by a further wrapping material, and the further wrapping material is circumscribed by the paper wrapping material.

49. The cigarette of claim 48 wherein the further wrapping material includes cellulosic material and at least one inorganic filler material.

50. The cigarette of claim 49 wherein the inorganic filler material of the further wrapping material includes calcium carbonate.

51. The cigarette of claim 49 wherein the inorganic filler material of the further wrapping material includes magnesium hydroxide.

52. The cigarette of claim 48 wherein the paper wrapping material includes wood pulp as a cellulosic base web component, and calcium carbonate as an inorganic filler material component.

53. The cigarette of claim 48 wherein the paper wrapping material comprises at least one inorganic filler material which includes calcium carbonate.

54. The cigarette of claim 48 wherein the additive package provides about 10 to about 35 percent of the paper wrapping material on a dry weight basis.

55. The cigarette of claim 48 wherein the additive package provides about 15 to about 30 percent of the paper wrapping material on a dry weight basis.

56. The cigarette of claim 48 wherein the additive package is such that the ratio of equivalents of (ii) to (iii) ranges from about 0.2 to about 0.5.

57. A cigarette comprising a rod of smokable material contained in a circumscribing paper wrapping material in intimate contact with an additive package, the paper wrapping material comprising a cellulosic base web and an additive package including water soluble components, which additive package

(a) provides about 5 to about 40 percent of that paper wrapping material on a dry weight basis; and

(b) includes (i) alkali metal ions and (ii) alkali earth metal ions, such that the ratio of equivalents of (i) to (ii) ranges from about 0.05 to about 1; and (iii) organic anions; the equivalents of components (i) plus (ii) being equal to the equivalents of component (iii).

58. The cigarette of claim 57 wherein the paper wrapping material includes a cellulosic base web and at least one inorganic filler material.

59. The cigarette of claim 58 wherein the inorganic filler material includes calcium carbonate.

60. The cigarette of claim 58 wherein the paper wrapping material, absent of the additive package, includes about 65 to about 95 percent cellulosic material and about 5 to about 35 percent inorganic filler material, on a dry weight basis.

61. The cigarette of claim 57 or 58 wherein more than 75 weight percent of the additive package in intimate contact with the paper wrapping material has a water soluble form.

62. The cigarette of claim 57 or 58 wherein the organic anions are acetate ions, propionate ions, formate ions or lactate ions.

63. The cigarette of claim 57 or 58 wherein alkali earth metal ions include calcium ions.

64. The cigarette of claim 54 or 58 wherein the organic filler material consists essentially of calcium carbonate.

65. The cigarette of claim 57 or 58 wherein the additive package includes a mixture of magnesium ions and calcium ions.

66. The cigarette of claim 57 or 58 wherein the additive package includes potassium ions.

67. The cigarette of claim 57 or 58 wherein the paper wrapping material comprising the additive package exhibits an inherent porosity of less than about 30 CRESTA units.

68. The cigarette of claim 57 or 58 wherein the additive package provides about 10 to about 35 percent of the dry weight of the paper wrapping material.

69. The cigarette of claim 57 or 58 wherein the additive package provides about 15 to about 30 percent of the dry weight of the paper wrapping material.

70. The cigarette of claim 57 or 58 wherein the additive package is such that the ratio of equivalents of (i) to (ii) ranges from about 0.2 to about 0.5.

71. The cigarette of claim 57 or 58 wherein the smokable material is circumscribed by a further wrapping material, and the further wrapping material is circumscribed by the paper wrapping material.

72. The cigarette of claim 71 wherein the further wrapping material includes cellulosic material and at least one inorganic filler material.

73. The cigarette of claim 72 wherein the inorganic filler material of the further wrapping material includes calcium carbonate.

74. The cigarette of claim 71 wherein the inorganic filler material of the further wrapping material includes magnesium hydroxide.

75. The cigarette of claim 71 wherein the paper wrapping material includes wood pulp as a cellulosic base web component, and calcium carbonate as an inorganic filler material component.

76. The cigarette of claim 71 wherein the paper wrapping material comprises at least one inorganic filler material which includes calcium carbonate.

77. The cigarette of claim 71 wherein the additive package provides about 10 to about 35 percent of the paper wrapping material on a dry weight basis.

78. The cigarette of claim 71 wherein the additive package provides about 15 to about 30 percent of the paper wrapping material on a dry weight basis.

79. The cigarette of claim 71 wherein the additive package is such that the ratio of equivalents of (i) to (ii) ranges from about 0.2 to about 0.5.

* * * * *

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US005396911A

United States Patent [19]

asey, III et al.

[11] Patent Number: 5,396,911

[45] Date of Patent: * Mar. 14, 1995

[54] SUBSTRATE MATERIAL FOR SMOKING ARTICLES

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[*] Notice: The portion of the term of this patent subsequent to Apr. 7, 2009 has been disclaimed.

[21] Appl. No.: 800,679

[22] Filed: Nov. 27, 1991

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 567,519, Aug. 15, 1990, Pat. No. 5,101,839.

[51] Int. Cl.[6] A24B 15/16

[52] U.S. Cl. 131/352; 131/194; 131/335; 131/343

[58] Field of Search 131/335, 343, 194, 365, 131/352, 356, 359

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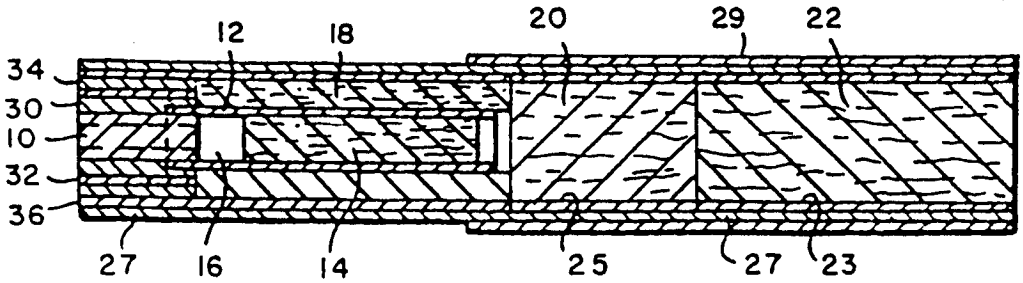
[57] ABSTRACT

Disclosed is a stabilized substrate composition for smoking articles, particularly cigarettes. In general, the stabilized substrate composition comprises an admixture of a binder and an aerosol forming material which plasticizes the binder, together with optional fillers and/or base materials. In the stabilized substrate compositions of the present invention the relative amounts of binder and aerosol former depend particularly on the situation in which the substrate composition is used. In general, the ratio of aerosol former to binder is between about 3:1 and about 40:1. When the stabilized composition is used on a base material such as tobacco cut filler, the ratio of aerosol former to binder should be at least about 15:1, and preferably is from about 25-35:1, with a maximum ratio of about 40:1. If the composition is formed into a cast sheet, the minimum ratio is about 3:1, the preferred ratio is about 8:1, and the maximum ratio is about 10:1. When the stabilized mixture is printed on a sheet or web substrate, the ratio of aerosol former to binder is generally about 6:1, the maximum ratio is about 10:1, and the minimum ratio is about 3:1.

72 Claims, 2 Drawing Sheets



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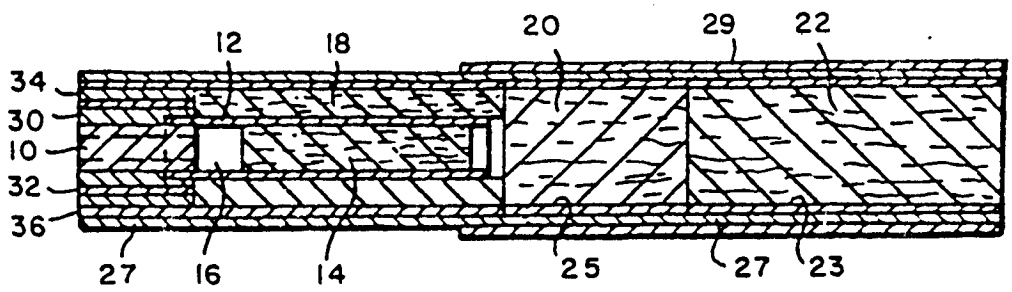

FIG. 1

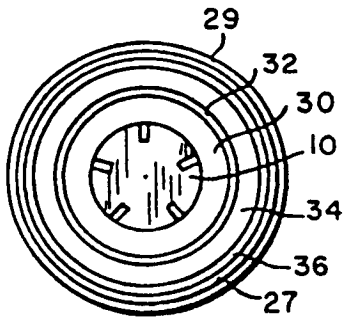

FIG. 1A

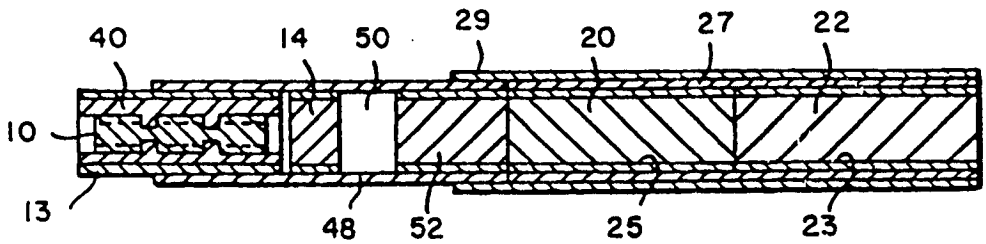

FIG. 2

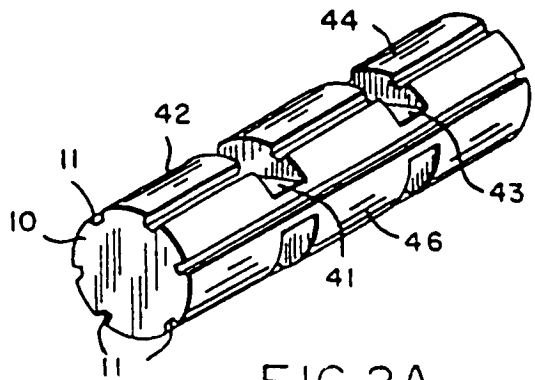

FIG. 2A

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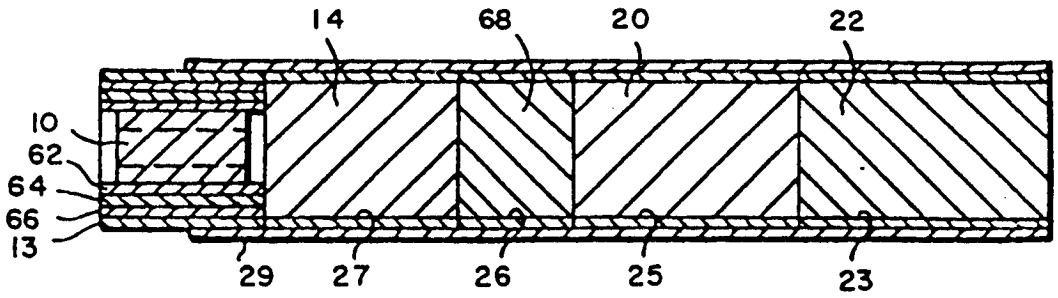

FIG. 3

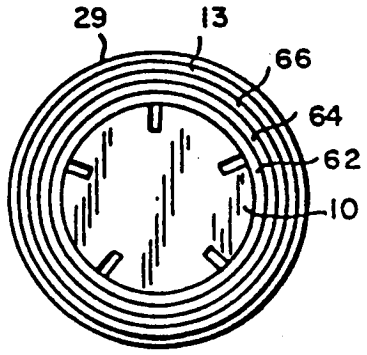

FIG. 3A

SUBSTRATE MATERIAL FOR SMOKING ARTICLES

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of application Ser. No. 07/567,519, filed Aug. 15, 1990, now U.S. Pat. No. 5,101,839, the disclosure of which is hereby incorporated herein by reference.

FIELD OF THE INVENTION

The present invention is directed to improvements in smoking articles, particularly smoking articles employing tobacco therein. Cigarettes, cigars and pipes are popular smoking articles which use tobacco in various forms. Many smoking products have been proposed as improvements upon, or alternatives to, the various popular smoking articles. For example, numerous references have proposed articles which generate a flavored vapor and/or a visible aerosol. Most of such articles have employed a combustible fuel source to provide an aerosol and/or to heat an aerosol forming material. See, for example, the background art cited in U.S. Pat. No. 4,714,082 to Banerjee et al.

BACKGROUND OF THE INVENTION

The present invention relates to smoking articles such as cigarettes, and in particular to those smoking articles having a short fuel element and a physically separate aerosol generating means. Smoking articles of this type, as well as materials, methods and/or apparatus useful therein and/or for preparing them, are described in the following U.S. Pat. Nos. 4,708,151 to Shelar; 4,714,082 to Banerjee et al.; 4,732,168 to Resce; 4,756,318 to Clearman et al.; 4,782,644 to Homer et al.; 4,793,365 to Sensabaugh et al.; 4,802,562 to Homer et. al.; 4,827,950 to Banerjee et al.; 4,870,748 to Hensgen et al.; 4,881,556 to Clearman et al.; 4,893,637 to Hancock et al.; 4,893,639 to White; 4,903,714 to Barnes et al.; 4,917128 to Clearman et al.; 4,928,714 to Shannon; 4,938,238 to Hancock et al., 4,989,619 to Clearman et al., 5,027,837 to Clearman et al., and 5,038,802 to White et al., as well as in the monograph entitled *Chemical and Biological Studies of New Cigarette Prototypes That Heat Instead of Burn Tobacco*, R. J. Reynolds Tobacco Company, 1988 (hereinafter "RJR Monograph"). These smoking articles are capable of providing the smoker with the pleasures of smoking (e.g., smoking taste, feel, satisfaction, and the like). Such smoking articles also typically provide low yields of visible sidestream smoke as well as low yields of FTC tar when smoked.

The smoking articles described in the aforesaid patents and/or publications generally employ a combustible fuel element for heat generation and an aerosol generating means, positioned physically separate from, and typically in a heat exchange relationship with the fuel element. Many of these aerosol generating means employ a substrate or carrier for one or more aerosol forming materials, e.g., polyhydric alcohols, such as glycerin. As the substrate material is heated by the burning of the fuel element, the aerosol forming materials are volatilized and released therefrom to form an aerosol.

The substrates used previously have included heat stable materials, i.e., materials which do not burn or decompose appreciably when subjected to the heat generated by the burning fuel element. Such materials include adsorbent carbons, such as porous grade carbons, graphite, activated carbons, or non-activated carbons, and the like. Other heat stable materials include inorganic solids, such as ceramics, glass, alumina, vermiculite, clays such as bentonite, and the like.

Other substrate materials used previously have included cellulosic materials, e.g., paper, tobacco paper and the like. These materials typically require a large amount of aerosol former to be present on the substrate to prevent scorching. The presence of large amounts of aerosol former also tends to promote migration of aerosol former from the substrate to other components of the smoking article.

It would be advantageous to have a substrate for smoking articles, particularly cigarettes, which could be manipulated using conventional cigarette making equipment, and which would hold sufficient aerosol forming material to provide aerosol over the 10–12 puff life of a cigarette. It would also be desirable that such a substrate would be stable during storage, i.e., the aerosol former would not appreciably migrate therefrom, to the other parts of the smoking article.

These and other desirable attributes of smoking articles, and particularly cigarettes, are provided by the smoking articles of the present invention, which are described below.

SUMMARY OF THE INVENTION

It has been discovered that polyhydric alcohol (polyol) aerosol forming materials, such as glycerin, propylene glycol, and the like, can be stabilized by the use of certain binders. It has further been discovered that these stabilized mixtures are useful in certain smoking articles, particularly those smoking articles, such as cigarettes employing a short fuel element and a physically separate aerosol generating means for the production of a smoke-like aerosol.

In particular, it has been discovered that aerosol forming materials can be intimately incorporated in a binder to form a stable product of admixture, from which migration of the aerosol former is minimized, particularly over long periods of time, e.g., under typical storage conditions. Such stable mixtures are sprayable, printable, castable, extrudable, or densifiable. Such mixtures may be used with a substrate base or substrate material, or may be used alone to form a substrate for smoking articles. Upon exposure to heat, e.g., from the burning fuel element of a smoking article, the aerosol forming substance is released to form an aerosol.

While not wishing to be bound by theory, it is believed that the aerosol forming materials useful herein serve as plasticizers for the binder. As with all true plasticizers, the aerosol former is a relatively nonvolatile solvent (at room temperatures) for the resinous substance (i.e., the binder) that, when compounded with the binder, increases its flexibility, workability or shock resistance. See, *The Technology of Solvents and Plasticizers*, Chapter 15, "Plasticizers and Plasticization," John Wiley & Sons, New York (1954), the disclosure of which is hereby incorporated herein by reference.

In the stabilized substrate compositions of the present invention the relative amounts of binder and aerosol former depend on the situation in which the substrate composition is used. In general, the ratio of aerosol former to binder is between about 3:1 and about 40:1. When the stabilized composition is used on cut filler, the ratio of aerosol former to binder should be at least about 15:1, and preferably is from about 25–35:1, with a

maximum ratio of about 40:1. If formed into a cast sheet, the minimum ratio is about 3:1, the preferred ratio is about 8:1, and the maximum ratio is about 15:1. When the stabilized mixture is printed on a sheet or web substrate, the ratio of aerosol former to binder is generally about 10:1, the maximum ratio is about 15:1, and the minimum ratio is about 3:1.

One preferred form of a substrate according to the present invention utilizes a cut filler material as the substrate base, and applied thereto is a mixture of an aerosol forming material stabilized by a binder. The amount of the aerosol/binder mixture is sufficient to provide adequate aerosol for each of about 8–12 puffs during smoking, and is preferably at least about 15 weight percent of the treated substrate. Preferably, the aerosol forming material and the binder are applied to a cut filler material such as tobacco, reconstituted tobacco, volume expanded tobacco, tobacco paper, or the like. Typically, the cut filler carrying the stabilized mixture is formed into a rod with a circumscribing paper wrapper.

The stabilized cut filler substrate may be prepared by either a one step or a two step process. In the one step process, cut filler material is sprayed with a stabilized admixture of aerosol former and binder together with sufficient water to provide a suitable viscosity for spraying. Thereafter, the treated cut filler material is dried to remove the water, at a temperature sufficiently low so as to prevent significant loss of aerosol forming materials, e.g., at up to about 100° C.

In the two step process, the aerosol forming material (e.g., glycerin) is sprayed on tobacco in a mixer, followed by spraying with an aqueous binder mixture (e.g., alginate) at a sprayable viscosity. Preferably the tobacco/aerosol former mixture is dried by heating at low temperatures (e.g., up to about 100° C.) while the aqueous binder mixture is applied, to drive off the excess water, without substantial loss of the aerosol former. The final moisture content of the cut filler substrate should be from about 8 to 12

Another preferred form of a substrate according to the present invention utilizes a sheet or web material as a substrate base, with a film or coating of a stabilized mixture of an aerosol former and a binder applied to the surface thereof. Normally the mixture includes at least about 15 weight percent of an aerosol former, preferably up to about 97 weight percent, and at least about 3 weight percent of binder. The amount of the aerosol former/binder mixture is sufficient to provide adequate aerosol delivery for about 8–12 puffs during smoking and preferably is at least about 15 weight percent. More preferably, the amount of stabilized aerosol former is about 80 to about 200 weight percent of the treated substrate. The coated sheet material can be gathered to form a rod having a circumscribed wrapper.

The coated sheet material may also be formed into cut filler and made into a rod with a circumscribing wrapper. Preferably the sheet material is a paper material which comprises tobacco, and may also include wood pulp or other filler materials, e.g., for body, strength, or stability. The sheet or web may also comprise a paper, a foil, e.g., aluminum foil, a woven or non-woven web, e.g., glass fiber mat, a film, such as an inert plastic film, or the like. Alternatively the coated sheet material can be shredded into strands, which then can be gathered into rods, as shown in Pryor et al., U.S. Pat. No. 4,889,143 and/or Raker, U.S. Pat. No. 5,025,814.

In one embodiment of a substrate according to the present invention, the base material of the substrate is a mat of glass fibers, preferably formed into an annular tube, circumscribing a core of the stabilized aerosol former/binder composition. The stabilized mixture can be incorporated into (or onto) the glass mat by any means available to the skilled artisan. In the annular tube embodiment, methods such as injection or extrusion may be employed- The annular glass mat tube containing the stabilized mixture would be thermally stable at the temperatures generated in smoking articles employing such a substrate.

In one preferred embodiment of a substrate according to this invention, a tobacco sheet or web, such as reconstituted tobacco or tobacco paper is formed and this sheet is coated, e.g., by spraying or printing with a film composition comprising a mixture of from about 20 weight percent to about 95 weight percent, preferably about 50 to 90 weight percent, most preferably from about 79 weight percent to about 85 weight percent by weight of glycerin, and from about 1 to about 25, preferably from about 2 weight percent to about 20 weight percent, most preferably from about 6 to about 15 weight percent ammonium alginate, such as that available from the Kelco Division of Merck & Co., Inc., San Diego, Calif., under the designation Amoloid LV (low viscosity) or Amoloid HV (high viscosity) or Collatex A/RN (Kelco).

The thus formed tobacco sheet, bearing the aerosol former stabilized with ammonium alginate, can be shredded for use in rods, or formed into cut filler rods, to prepare substrates for cigarettes and other smoking articles. If desired, the tobacco sheet, bearing the aerosol former stabilized with ammonium alginate or other binder can be formed into a gathered or rolled web, and this formed web may be used as a substrate. Other modifications of the manner in which the sheet is employed as a substrate will be apparent to the skilled artisan.

Another composition useful for making a substrate according to the present invention is provided by a mixture of at least about 15 weight percent of an aerosol forming material and at least about 3 weight percent of a binder, and preferably up to about 82 weight percent of one or more filler materials, which can be cast, extruded or otherwise formed into a sheet or film-like material. Preferably the filler materials include tobacco in some form. The filler material may alternatively or additionally comprise an inorganic material, such as calcium carbonate or other inorganic salt.

In general, the stabilized sheet substrate of the present invention comprises an intimate mixture of from about 30 to about 55 weight percent of (i) tobacco (e.g., shredded tobacco laminae, milled tobacco laminae, pieces of tobacco stems, tobacco fines, tobacco dust, or a tobacco extract or other form of processed tobacco), and optionally from about 0 to about 25 weight percent of (ii) one or more filler materials, e.g., inorganic fillers such as precipitated calcium carbonate or the like. The substrate also includes (iii) from about 40 to about 50 weight percent of one or more aerosol forming materials (e.g., polyols, such as glycerin and/or propylene glycol). The substrate also includes (iv) from about 5 to about 8 weight percent of a binding agent, which serves to stabilize the other components, preventing migration of the polyol. An especially preferred binding agent is an alginate, such as ammonium alginate. Advantageously, when tobacco materials are used in the mixture, a cross-linking destruction or releasing agent can

used to liberate the natural binders present in the tobacco (e.g., pectinaceous materials). These released naturally occurring binders may then be used to stabilize the aerosol forming materials. A combination of binders, e.g., released natural tobacco binders and added binders (e.g., alginates) may be used if desired.

The substrate mixture can also include optional flavoring agents (e.g., cocoa, licorice, organic acids, menthol, tobacco based flavors, and the like.) Preferably the flavorants are added in liquid or spray dried form, preferably at the same time as or after the addition of the aerosol forming material to the binder/water mixture. Alternatively, the flavoring agents can be dry mixed with the material at other stages of the process.

The substrate mixture can be cast as a sheet from an aqueous slurry, extruded, molded or otherwise formed into the desired sheet form. Such a substrate can be employed in gathered web form, shredded and gathered into a rod, or used in the form of cut filler. It can be used as the sole substrate of a cigarette or, alternatively, this substrate can be physically mixed with or otherwise employed with other substrate materials, such as tobacco cut filler or inorganic substrates, to form a heterogeneous substrate mixture, or a series of substrate segments. In another embodiment of the present invention, flavoring agents such as menthol are directly incorporated in the substrate composition. One method for directly incorporating menthol involves the formation of an aqueous slurry containing a binder, an aerosol forming material, and a menthol-containing organic or organic filler material. An especially preferred organic filler material for use with menthol is activated carbon, treated to retain from about 1 to about 50 weight percent, preferably from about 5 to about 30 weight percent menthol. The carbon/menthol mixture may be prepared by milling activated carbon with solid menthol. During the milling, the menthol vaporizes (or sublimes) and the activated carbon adsorbs and/or absorbs the menthol.

The carbon/menthol slurry generally includes from about 40 to about 90 weight percent of one or more aerosol forming materials (e.g., polyols, such as glycerin and/or propylene glycol). The slurry also includes from about 5 to about 15 weight percent of a binding agent, which serves to stabilize the other components, preventing migration of the flavor material and/or the aerosol forming materials. An especially preferred binding agent is an alginate, such as ammonium alginate.

The slurry may be cast onto a substrate sheet material as described above for the other substrate compositions and air dried under ambient conditions to drive off excess moisture. This substrate composition can be shredded into cut filler or made into a gathered web. This composition as cut filler or gathered web can be made into 7.5 mm diameter paper wrapped rods and cut into 10 mm sections to be used as substrates. Other components can be included in the slurry, e.g., tobacco, inorganic fillers, and the like. As the skilled artisan will appreciate, depending upon the thickness of the slurry, the handling thereof can be varied. For instance, a dilute slurry can be sprayed or printed onto a substrate base material. A slightly thicker slurry can be cast into a sheet form. Still thicker slurries can be extruded and/or densified to form a suitable substrates.

In those preferred embodiments where ammonium alginate is used as a stabilizing binder, it is preferable to add a sequestering agent, such as potassium carbonate, potassium acetate, or other known sequestering agent, to exert some control over the alginate polymerization process.

Regardless of the shape, form or compositional make-up in which it is employed, the substrate material of this invention retains the aerosol forming materials during storage, and releases the materials gradually during smoking. Temperatures as low as from about 180° to 200° C. are typically sufficient to cause a release of the aerosol former, thereby minimizing the amount of fuel necessary for the smoking device.

It has been discovered that low viscosity binders are most useful in those applications where the stabilized mixture is to be sprayed, while high viscosity binders are most useful in those applications where the stabilized mixture is to be cast or otherwise formed into a sheet or web structure. There appears to be no significant difference in the holding power (i.e., as to the binding or retention of the aerosol former) between the high viscosity and the low viscosity binders. As the skilled artisan will appreciate from this disclosure, the most preferred binders are those which will effectively hold a large quantity of aerosol former.

Preferred substrates of the present invention provide tobacco taste, permit little or no migration of the aerosol former, are simple to manufacture, and are easy to incorporate into smoking articles using conventional equipment. The substrates provide adequate quantities of aerosol during use, provide a large number of puffs, with high aerosol content, in the typical cigarette structures employing the substrate. The substrates of the present invention, in various cigarette structures, provide the opportunity to avoid use of metallic heat conductors, such as the aluminum conductive structures used in some prior cigarettes, and to avoid anti-migration measures previously utilized in certain smoking article structures, such as the spacing of the aerosol generating means from the fuel element, and the like. The present substrates are not only stable, but they are lighter in weight than certain prior substrate materials, and provide other advantages as well.

As used herein, the term "aerosol" is meant to include vapors, gases, particles, and the like, both visible and invisible, and especially those components perceived by the smoker to be "smoke-like," formed by the action of heat generated by the fuel element upon materials contained within the aerosol generating means, or elsewhere in the smoking article.

As used herein, the term "carbonaceous" means comprising primarily carbon.

All weight percentages given herein are based on the final composition weights, unless otherwise noted.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional illustration of one configuration of a cigarette having the substrate composition prepared according to the present invention.

FIG. 1A is an end view of the cigarette shown in FIG. 1.

FIG. 2 illustrates in sectional view, another embodiment of a cigarette which may employ the substrate of the present invention.

FIG. 2A is a top plan view of the fuel element used in the cigarette shown in FIG. 2.

FIG. 3 illustrates in sectional view, another embodiment of a cigarette which may employ the substrate of the present invention.

FIG. 3A is an end view of the cigarette shown in FIG. 3.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

As described above, the present invention is particularly directed to a substrate useful in smoking articles, such as the RJR Monograph cigarette and other smoking articles, such as those described in U.S. Pat. Nos. 4,793,365; 4,928,714; 4,714,082; 4,756,318; 4,854,331; 4,708,151; 4,732,168; 4,893,639; 4,827,950; 4,858,630; 4,938,238; 4,903,714; 4,917,128; 4,881,556; 4,991,596; and 5,027,837; U.S. patent application Ser. Nos. 07/642,233, filed Jan. 23, 1991, 07/713,939, filed Jun. 12, 1991, and 07/723,350, filed Jun. 28, 1991, which are hereby incorporated herein by reference. See also, European Patent Publication No. 342,538.

FIGS. 1 and 1A illustrate a cigarette having a carbonaceous fuel element 10, circumscribed by a jacket comprising alternating layers of glass fibers 30 and 34 and tobacco paper 32 and 36. Located longitudinally behind the fuel element, and in contact with a portion of the rear periphery thereof is a sleeve 12. The sleeve carries the substrate material 14 of the present invention, which contains stabilized aerosol forming materials, and is spaced from the fuel element, forming gap 16. Surrounding the sleeve 12 is a roll of tobacco 18 in cut-filler form. The mouthend piece of the cigarette is comprised of two parts, a tobacco paper segment 20 and a low efficiency polypropylene filter material 22. As illustrated several paper layers 23, 25, 27 and 29, are employed to hold the cigarette and/or its individual components together.

Heat from the burning fuel element is transferred by conduction and convection to the substrate in the sleeve. During puffing the aerosol forming material carried by the substrate is vaporized and then condenses to form a smoke-like aerosol which is drawn through the smoking article, absorbing additional tobacco and other flavors from other components of the smoking article and exits the mouthend piece.

Referring in detail to FIGS. 2 and 2A, there is respectively illustrated one preferred embodiment of the cigarette of the present invention and a symmetrical fuel element therefor. As illustrated, the cigarette includes a segmented fuel element 10 circumscribed and recessed within a retaining jacket of insulating material 40. The insulating and retaining jacket material 40 comprises glass fibers.

As illustrated in FIG. 2A, the fuel element 10, has a generally cylindrical shape and has several longitudinally extending peripheral channels 11. The fuel element has a segmented design which includes three longitudinally positioned portions or segments, consisting of two end portions 42 and 44 and one intermediate portion 46. When positioned in the cigarette of FIG. 2, one of the end portions 42 or 44 serves as the burning segment, while other 44 or 42 serves as the base segment. Intermediate segment 46 is separated (i.e., isolated) from each of the end segments by two areas of reduced cross-sectional area 41 and 43, which serve as isolation segments.

As shown in FIG. 2, the insulating and retaining jacket 40 circumscribes the longitudinal periphery of fuel element 10 and extends beyond each end of the fuel element, such that the fuel element is recessed within the insulating and retaining jacket. Such placement assists in the retaining function of the jacket. Preferred fibrous (e.g., glass fibers) jackets shrink slightly when exposed to the heat of the burning fuel element, thereby further surrounding the fuel element and retaining it in place.

Situated longitudinally behind the fuel element 10 is an aerosol generating means, which comprises a substrate 14 prepared as described herein. The substrate 14 holds one or more aerosol forming materials and flavor components, which are volatilized by heat generated by the burning of the fuel element. The substrate 14 is positioned within the cigarette at a location remote from the rear end of the fuel element 10. This spaced apart relationship assists in preventing migration of the aerosol forming material(s) from the substrate to the fuel element and assists in preventing the substrate from scorching or burning.

Surrounding the insulating and retaining jacket 40 is an air permeable paper wrapper 13. Wrapper 13 may comprise one layer or it may be prepared from two separate layers, each having different porosity and ash stability characteristics. Circumscribing the insulated fuel element at about the junction of the burning segment 42 and the isolation segment 41, and extending back over the substrate 14 is a non-burning or foil-backed (e.g., aluminum or other metal) paper wrapper 48. Wrapper 48 is preferably a non-wicking material which prevents the wicking of the aerosol forming material(s) on the substrate 14 to the fuel element 10, the insulating jacket 40, and/or from staining of the other components of the front end assembly. This wrapper also minimizes or prevents peripheral air (i.e., radial air) from flowing to the segments of the fuel element disposed longitudinally behind the burning segment, thereby causing oxygen deprivation and preventing excessive combustion. While not preferred, wrapper 48 may extend over the burning end of the fuel element 10 (or beyond the same) and be provided with a plurality of perforations (not shown) to allow controlled radial air flow to the burning segment of the fuel element to support combustion.

Situated longitudinally behind the substrate 14 is a void space 50. Void space 50 acts as a cooling and nucleation chamber wherein the hot volatile materials exiting the substrate cool down and form an aerosol. Void space 50 may be partially or completely filled, e.g., as shown at 52 with tobacco or reconstituted tobacco, e.g., in cut filler form, or with other tobacco materials, e.g., tobacco paper and the like, to contribute additional tobacco flavors to the aerosol.

Positioned at the extreme mouth end of the cigarette is a two part mouthend piece comprising (i) a rod or roll of tobacco, such as tobacco paper 20 and (ii) a low-efficiency filter element 22 including a filter material, such as a gathered web of non-woven polypropylene fibers.

Each of the above described elements of the cigarette of the present invention is generally provided with a paper overwrap, and individual overwrapped segments are typically combined by the use of paper overwraps. Advantageously, the paper overwrap of the substrate is a non-wicking paper. These papers are shown in FIG. 2 as reference numbers 23–26.

In use, the smoker lights fuel element 10 (e.g., using a cigarette lighter) and the burning segment 30 burns to produce heat. During draw, air passes along the periphery of the burning segment 42 (including down channels 11) as well as through the retaining and insulating jacket 40. The drawn air is heated by contacting the burning segment of the fuel element and by heat radiated from the fuel element. The heated air transfers heat by convection to the substrate 14 and this transferred heat

volatilizes the aerosol forming and flavor materials carried by the substrate. The volatilized material within the hot drawn air exits the substrate and then cools during passage through void space 50, forming an aerosol. The aerosol passes through the tobacco or tobacco papers 52 and 20 absorbing additional tobacco flavors, and passes through the filter material 22, and into the mouth of the smoker. Since the base portion of the fuel element 44 does not burn during the use of the cigarette, the fuel element remains securely in the cigarette and does not have a tendency to become dislodged from the cigarette during use. When the fuel element self-extinguishes and no longer generates heat, the cigarette is disposed of.

As illustrated in FIGS. 1 & 2, the substrate is positioned behind the fuel element, in a spaced apart relationship relative to the back end of the fuel element so as to have an air space or gap therebetween. This can be accomplished by abutting the substrate against the insulating jacket or by providing a gap or space between the jacketed fuel element and the substrate during manufacture. Such a gap is typically provided to prevent scorching of the substrate materials by the hot gases emanating from the rear of the burning fuel element. This gap also assists in preventing migration of the aerosol forming materials from the aerosol generating means to other components of the cigarette, particularly the fuel element. If desired, the back end of the fuel element and the front end of the substrate may be spaced from about 1 mm to about 10 mm apart, preferably from about 2 mm to about 5 mm apart.

As illustrated in FIG. 2, another void space may also be provided immediately behind the substrate. Such a void space can provide a zone for aerosol formation, and is preferably from about 1 to about 20 mm in length. Such an aerosol forming zone is typically located forward of any tobacco cut filler, tobacco paper or the like, so that the aerosol may pass therethrough and absorb tobacco flavors.

FIG. 3 illustrates another embodiment of a cigarette which can utilize the substrates of the present invention. As illustrated, a multi-part insulating and retaining jacket circumscribes the longitudinal periphery of fuel element 10 and extends beyond each end of the fuel element, such that the fuel element is recessed within the insulating and retaining jacket. As illustrated in FIG. 3A, the multi-part insulating jacket comprises alternating layers of C-glass fibers and tobacco paper, arranged as concentric rings emanating outwardly from the fuel element in the following order; (a) C-glass 62; (b) tobacco paper 64; and (c) C-glass 66; and an outer paper wrapper 13.

Situated immediately behind the insulated fuel element 10, i.e., in an abutting end-to-end relationship, is the aerosol generating means, which comprises a substrate 14, prepared as described herein. In this embodiment, which is most preferred, the stabilized nature of the substrate composition, in conjunction with the recessed nature of the fuel element 10 within insulating jacket, are factors which help to prevent migration of the aerosol forming materials out of the aerosol generating means into other components of the cigarette. The substrate 14 holds one or more stabilized aerosol forming materials and optional flavor components, which are volatilized by heat generated by the burning of the fuel element.

The wrapper 13 is an air permeable wrapper, which may comprise one layer or it may be prepared from two separate layers, each having different porosity and ash stability characteristics. Circumscribing the insulated fuel element, at a point about 2 to 8 mm from the lighting end of the cigarette, is a non-burning or foil-backed (e.g., aluminum or other metal) paper wrapper 48. Wrapper 48 is preferably a non-wicking material which prevents the wicking of the aerosol forming material(s) on the substrate 14 to the fuel element 10, the insulating jacket, and/or from staining of the other components of the front end assembly. This wrapper also minimizes or prevents peripheral air (i.e., radial air) from flowing to the portion of the fuel element disposed longitudinally behind its forward edge, thereby causing oxygen deprivation and preventing excessive combustion. While not preferred, wrapper 48 may extend over the burning end of the fuel element 10 (or beyond the same) and be provided with a plurality of perforations (not shown) to allow controlled radial air flow to the burning segment of the fuel element to support combustion.

Situated longitudinally behind substrate 14 is a segment of tobacco paper 68. This tobacco paper generally provides tobacco flavors to the aerosol emitted from the aerosol generating means.

Positioned at the extreme mouth end of the cigarette is a two part mouthend piece comprising (i) a rod or roll of tobacco, such as tobacco cut filler 20 and (ii) a low-efficiency filter element 22 including a filter material, such as a gathered web of non-woven polypropylene fibers.

Each of the above described elements of the cigarette of the present invention is generally provided with a paper overwrap, and individual overwrapped segments are typically combined by the use of paper overwraps. Advantageously, the paper overwrap of the substrate is a non-wicking paper. These papers are shown in FIG. 3 as reference numbers 23–26. A tipping paper 29 is used to join the mouthend piece to the front end assembly.

In use, the smoker lights fuel element 10, e.g., using a cigarette lighter, and the fuel burns to produce heat. During draw, air passes along the periphery of the burning fuel element 10, as well as through the retaining and insulating jacket. The drawn air is heated by contacting the burning segment of the fuel element and by heat radiated from the fuel element. The heated air transfers heat by convection to the substrate 14 and this transferred heat volatilizes the aerosol forming and flavor materials carried by the substrate. The volatilized material forms an aerosol during its progression through the substrate, which aerosol is then drawn through the other components during smoking. The aerosol passes through the tobacco or tobacco papers 68 and 20 absorbing additional tobacco flavors, and passes through the filter material 22, and into the mouth of the smoker.

As described in the illustrated embodiments, the aerosol generating means includes a substrate for carrying the aerosol forming material. The substrates of the present invention typically comprises a base material which serves as a carrier, and a stabilized aerosol forming substance, which is generally referred to herein as the substrate composition. Preferred substrate compositions retain the aerosol forming material when not in use, and release the aerosol forming material during smoking. Most preferably, the substrate base compositions and/or the substrate compositions of the present invention incorporate some form of tobacco. The form of the tobacco can vary, and, if desired, more than one form of tobacco may be employed in the substrate composition.

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The stabilized substrate composition of the present invention includes an aerosol forming material (e.g., glycerin) and a binding agent. Tobacco extracts and/or pieces of tobacco laminae can be incorporated into the substrate composition, and/or the substrate composition can be applied to and/or blended with tobacco cut filler. Substrates for cigarettes and other smoking articles are provided by wrapping the final substrate composition and optional base or carrier material, in a paper wrapping material.

To form a stabilized substrate composition, the present invention combines one or more binding agents with one or more aerosol forming materials. Preferred binding agents include the alginates, such as ammonium alginate, propylene glycol alginate, potassium alginate and sodium alginate. The alginates, and particularly the high viscosity alginates, can be employed in conjunction with controlled levels of free calcium ions.

Numerous commercial sources of alginate binders are available worldwide. Some of the U.S. sources include; American Roland Chemical Corp., Farmingdale, N.Y.; Belmont Chemicals, Inc., Passaic, N.J.; Colony Import & Export Corp., Garden City, N.Y.; Food Ingredients, Inc., Fort Lee, N.J.; Grinstead Products, Industrial Airport, Kans.; Gum Technology, Flushing, N.Y.; Gumix International, Fort Lee, N.J.; Kelco, Inc., San Diego, Calif.; Meer Corp., North Bergen, N.J.; Multi-Kem Corp., Ridgefield, N.J.; National Stabilizers, Duarte, Calif.; Orion Group (USA), Ltd., San Jose, Calif.; Pacific Gateway, San Francisco, Calif.; Penta Manufacturing Co., Fairfield, N.J.; Protan, Inc., Portsmouth, N.H.; Sanofi Bio-Indust. Inc., Germantown, Wis.; Skymart Enterprises, San Gabriel, Calif.; Spice King Corp., Culver City, Calif.; TIC Gums, Inc., Belcamp, Md.; Wego Chemical & Mineral Corp., Great Neck, N.Y. and Zumbro, Inc., Hayfield, Minn.

Another preferred class of binders for use herein, either alone, or in admixture with an other binders (e.g., alginates) are the binders naturally occurring in tobacco (e.g., pectins and the like). As used herein, the terms "natural tobacco pectin binders" refers to "liberated" tobacco pectins and includes pectins which have been chemically freed or otherwise liberated from their natural state in tobacco. In other words, the liberated pectins are not bound into the tobacco structure. Thus, the term includes free pectinic or pectic acid, as well as soluble salts such as the sodium, potassium, and ammonium, pectates and pectinates, and insoluble salts such as the calcium and magnesium pectates and pectinates, depending on what method is employed to liberate and obtain them from the naturally occurring insoluble source. See for example, U.S. Pat. No. 3,435,829 to Hind et al., the disclosure of which is hereby incorporated herein by reference.

As described in U.S. patent application Ser. No. 07/769,914, filed 30 September 1991, tobacco may be treated with an agent capable of destroying the alkaline earth metal crosslinks of pectins present within that material. Such an agent commonly is referred to as a "crosslink destruction agent" or a "pectin release agent." One preferred crosslink destruction agent is diammonium hydrogen orthophosphate.

Other useful binding agents include hydroxypropylcellulose such as Klucel H from Aqualon. Co.; hydroxypropylmethylcellulose such as Methocel K4MS from The Dow Chemical Co.; hydroxyethylcellulose such as Natrosol 250 MRCS from Aqualon Co.; methylcellulose such as Methocel A4M from The Dow Chemical Co.; and sodium carboxymethylcellulose such as CMC 7HF and CMC 7H4F from Hercules Inc. Other useful binding agents include starches (e.g., corn starch), guar gum, carrageenan, locust bean gum, and xanthan gum.

Examples of preferred aerosol forming materials include the polyhydric alcohols (e.g., glycerin, propylene glycol, triethylene glycol and tetraethylene glycol), the alipahtic esters of mono-, di-, or poly-carboxylic acids (e.g., methyl stearate, dimethyl dodecandioate and dimethyl tetradecanedioate), Hystar TPF available from Lonza, Inc., and the like, as well as mixtures thereof. For example, glycerin, triethylene glycol and Hystar TPF can be mixed together to form an aerosol forming material. The aerosol forming material can be provided as a portion of the binding agent (e.g., when the binding agent is propylene glycol alginate). Combinations of aerosol forming materials can be employed.

Upon consideration of the teachings provided herein, it is believed that a variety of appropriate combinations of aerosol former and binder can be determined by those having ordinary skill in this art. For example, such a combination can be made by selecting a binder which can stabilize a chosen aerosol former, preferably one which can be solvated (or plasticized) by a chosen aerosol former.

The aerosol forming materials may include volatile or other flavoring agents and tobacco flavor modifiers. Suitable flavoring agents include menthol, vanillin, cocoa, licorice, organic acids, high fructose corn syrup, and the like. Tobacco flavor modifiers such as levulinic acid, metal salts (e.g., sodium, potassium, calcium and magnesium) of levulinic acid, and the like, may also be used. Other useful flavoring agents for smoking articles are set forth in Leffingwell et al., *Tobacco Flavoring For Smoking Products* (1972) and in European Patent Publication No. 407,792.

If desired, inorganic materials can be incorporated as fillers in the substrate compositions of the present invention. Such inorganic materials often have a fibrous, flake, crystalline, amorphous, hollow or particulate form. Examples of useful inorganic filler materials include calcium carbonate, calcium sulfate particles, magnesium oxide, magnesium hydroxide, perlite, synthetic mica, vermiculite, clays, thermally stable carbon fibers, zinc oxide, dawsonite, low density hollow spheres of calcium carbonate, glass spheres, glass bubbles, thermally stable carbon microspheres, alumina, calcium carbonate agglomerated using a carbonaceous component, calcium carbonate agglomerated using an organic material, low density processed calcium carbonate and the like. Typically, the substrate compositions of the present invention are provided by forming an aqueous slurry comprising the aerosol forming material, the binding agent and any other components of the substrate composition. This composition may then be formed into a useful substrate for cigarettes and other smoking articles by any processing methods available to the skilled artisan. Several preferred methods include; (1) spraying the stabilized aerosol former/binder mixture onto a substrate base material, such as tobacco cut filler, or the like; (2) printing or otherwise forming a film of the stabilized aerosol former/binder mixture onto a solid base material, such as reconstituted tobacco paper, other papers (e.g., wood pulp containing materials) and the like; (3) by casting a slurry comprising the stabilized aerosol former/binder mixture and one or more filler materials, e.g., an inorganic filler (e.g., $CaCO_3$) and/or an organic filler (e.g., tobacco) into a

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sheet, and drying the cast material to form a relatively, dry workable sheet; (4) extruding a relatively thick slurry into discretely shaped particles, which may also include one or more passageways or channels therein or thereon, for modification of the surface area; and/or (5) a densified product, wherein an extruded stabilized mixture is treated to one or more processes which increase the density thereof, e.g., by the application of centrifugal force. See, for example U.S. Pat. No. 4,893,639 to White.

Other materials, such as calcium acetate, potassium carbonate, pH control agents, urea, amino acids, potassium chloride and/or calcium hydroxide, can be incorporated into the castable slurry, if desired. Techniques and equipment for forming substrates of this type by spraying, printing, casting, extruding and/or densifying are all commercially available, and will be readily apparent to the skilled artisan.

When ammonium alginate binders are employed in the cast sheet type compositions of the present invention, sequestering agents may preferably be added thereto. Sequestering agents (e.g., diammonium hydrogen orthophosphate, sodium citrate, potassium carbonate, potassium citrate, potassium hexametaphosphate, tetrasodium pyrophosphate, and the like) are typically incorporated into the substrate composition slurry in amounts sufficient to control the free calcium ion concentration in the slurry.

The formed substrate material can be dried at ambient temperatures or at slightly elevated temperatures, sufficient to drive off excess water, but without driving off desired components, e.g., the aerosol forming materials, flavor components, and the like. If desired, an aqueous solution of calcium salts can be applied to the substrates after formation.

The most preferred substrate compositions of the present invention have some form of tobacco incorporated therein during manufacture. The tobacco can have a variety of forms, including tobacco extracts, tobacco fines or dust, shredded or comminuted tobacco laminae, tobacco stems, volume expanded tobacco filler and other processed forms of tobacco, and the like, and combinations thereof.

One form of tobacco especially useful herein is tobacco cut filler (e.g., strands or shreds of tobacco filler having widths of about 1/15 inch to about 1/40 inch, and lengths of about ¼ inch to about 3 inches). Tobacco cut filler can be provided in the form of tobacco laminae, volume expanded or puffed tobacco laminae, processed tobacco stems including cut-rolled or cut-puffed stems, or reconstituted tobacco material.

Processed tobaccos, such as those described in U.S. Pat. No. 5,025,812 to Fagg et al., or U.S. Pat. Nos. 4,065,775 to Fagg and 5,131,414 to Fagg et al. can also be employed. Reconstituted tobacco material can be provided using cast sheet techniques such as those provided in U.S. patent application Ser. No. 4,099,864 to Young et al. or by papermaking techniques, such as those described in U.S. Pat. Nos. 4,962,774 to Thomasson et al. and 4,987,906 to Young et al., as well as in U.S. patent application Ser. Nos. 07/647,329, filed Jan. 28, 1991; or extrusion techniques, such as are described in U.S. Pat. No. 4,821,749 to Toft et al.; or-by volume expansion techniques, such as those described in U.S. Pat. No. 5,095,922 to Johnson et al. Other reconstituted tobacco materials useful in the cigarettes of the present invention are prepared using processes described in U.S. patent application Ser. No. 07/710,273, filed Jun. 4, 1991.

Cut filler, prepared as described herein as a substrate, is generally incorporated into the cigarette as a cylindrical roll or charge of tobacco material which is wrapped in a circumscribing paper wrapper. Tobacco cut filler can be provided as a roll in a paper wrapper using cigarette rod making techniques and apparatus which are well known by the skilled artisan.

Another form of tobacco useful herein is tobacco paper. For example, a web of tobacco paper available as P-144-GNA from Kimberly-Clark Corp. can be gathered into a cylindrical segment in a manner set forth in Example 2 of U.S. Pat. No. 4,807,809 to Pryor et al.

Another form of tobacco useful herein is finely divided tobacco material. Such a form of tobacco includes tobacco dust and finely divided tobacco laminae. Typically, finely divided tobacco material is carried by the substrate which is positioned within the aerosol generating means. However, finely divided tobacco material also can be incorporated into the fuel element.

Another form of tobacco useful herein is tobacco extract. Tobacco extracts are typically provided by extracting a tobacco material using a solvent such as water, carbon dioxide, sulfur hexafluoride, a hydrocarbon such as hexane or ethanol, a halocarbon such as a commercially available Freon, as well as other organic and inorganic solvents. Tobacco extracts can include spray dried tobacco extracts, freeze dried tobacco extracts, tobacco aroma oils, tobacco essences and other types of tobacco extracts. Methods for providing suitable tobacco extracts are set forth in U.S. Pat. Nos. 4,506,682 to Mueller, 4,986,286 to Roberts et al., 5,005,539 to Fagg, 5,060,669 to White et al., 5,121,757 to White et al., and 5,131,415 to Munoz et al., and European Patent Publication No. 338,831; and U.S. patent application Ser. Nos. 07/452,175, filed Dec. 18, 1989, 07/536,250, filed Jun. 11, 1990, 07/680,207, filed Apr. 4, 1991, 07/709,959, filed Jun. 4, 1991, 07/710,273, filed Jun. 4, 1991, and 07/717,457, filed Jun. 19, 1991.

Also useful are flavorful tobacco compositions such as those described in U.S. Pat. No. 5,016,654 to Bernasek et al. Another form of tobacco is enzymatically treated tobacco extract. This extract is described in U.S. patent application Ser. Nos. 07/721,860, filed Jun. 21, 1991, and 07/746,252, filed Aug. 15, 1991.

Preferred substrate compositions of the present invention normally include at least about 15, usually at least about 20, often at least about 25, frequently at least about 30, and sometimes at least about 40 weight percent aerosol forming material. Typically, the substrate composition includes up to about 70, and usually up to about 60 weight percent aerosol forming material. The substrate composition also typically includes up to about 20, preferably about 3 to about 15 weight percent binding agent; and up to about 80 percent preferably about 40 to about 75 weight percent filler component in particular, the filler component can include an organic filler material (e.g. tobacco dust or milled tobacco laminae) and/or inorganic filler materials (e.g., precipitated calcium carbonate).

Optionally, an amount of flavoring agent sufficient to provide the desired flavor characteristics to the substrate composition can be incorporated into the substrate material. Similarly, if desired, a carbonaceous material (e.g., pyrolyzed alpha cellulose) can be incorporated into the substrate material, frequently up to about 10 weight percent, based on the total dry weight

of the substrate material. However, such carbonaceous material is not a necessary component of the substrate material, and the substrate material can be absent of such carbonaceous material. While not necessary in most smoking articles, the substrate composition can be combustible, and/or it can be blended with other combustible substrate materials.

One preferred substrate of the present invention thus comprises an intimate mixture of (i) tobacco (e.g., shredded tobacco laminae, milled tobacco laminae, pieces of tobacco stems, tobacco fines, tobacco dust, or a tobacco extract or other form of processed tobacco), and optionally (ii) inorganic filler material. The substrate further includes a relatively high level of a stabilized aerosol forming . material, e.g., a polyol, such as glycerin and a binding agent, in order to maintain the components of the substrate composition together. An especially preferred binding agent is an alginate, such as ammonium alginate.

This tobacco containing substrate also can include certain flavoring agents (e.g., cocoa, licorice, organic acids, menthol, and the like) in intimate contact therewith. The tobacco containing substrate can be cast as a sheet from an aqueous slurry, or provided in extruded form. Such a tobacco containing substrate can be a form of reconstituted tobacco, and can be employed individually as the sole substrate material of the cigarette. Alternatively, such a tobacco containing substrate can be physically mixed with (e.g., blended) or otherwise employed with other substrate materials, such as tobacco cut filler, or with inorganic substrate materials.

Another preferred embodiment of the present invention includes flavoring agents such as menthol, directly incorporated in the substrate composition. In one embodiment the stabilized sheet substrate advantageously comprises an intimate mixture of from about 30 to about 55 weight percent of tobacco (e.g., shredded tobacco laminae, milled tobacco laminae, pieces of tobacco stems, tobacco fines, tobacco dust, or a tobacco extract or other form of processed tobacco), and from about 1 to about 25 weight percent, preferably from about 2 to about 15 weight percent, and most preferably from about 5 to about 8 weight percent of one or more organic filler materials, such as activated carbon, non-activated carbon, or similar organic fillers. The preferred organic filler material, activated carbon, preferably contains from about 1 to about 50 weight percent menthol, preferably from about 5 to about 30 weight percent menthol. The substrate also includes from about 40 to about 90 weight percent of one or more aerosol forming materials (e.g., polyols, such as glycerin and/or propylene glycol). The substrate also includes from about 5 to about 15 weight percent of a binding agent, which serves to stabilize the other components, preventing migration of the flavor material and/or the aerosol forming materials. An especially preferred binding agent is an alginate, such as ammonium alginate.

The menthol containing substrate can be cast as a sheet from an aqueous slurry, or provided in extruded form. Such a menthol containing substrate can be applied e.g., cast onto a reconstituted tobacco sheet, or be physically mixed with (e.g., blended) or otherwise employed with other substrate materials, such as tobacco cut filler, or with inorganic substrate materials.

As discussed above, the substrate compositions of the present invention can be blended with or otherwise applied to tobacco, in any form, especially cut filler. The type of tobacco can vary, and can include flue cured Burley, Maryland and Oriental tobaccos, as well as the rare and specialty tobaccos, and blends thereof. Such tobacco cut filler can be provided in the form of tobacco laminae: volume expanded or puffed tobacco laminae: processed tobacco stems such as cut-rolled or cut-puffed stems: reconstituted tobacco materials, such as (i) deproteinated tobacco materials described in U.S. Pat. Nos. 4,887,618 to Bernasek et al. and 4,941,484 to Clapp et al. (ii) a phosphate-containing reconstituted tobacco material described in U.S. Pat. Nos. 3,353,541 and 3,420,241 to Hind et al. and 3,386,449 to Hind, 4,987,906 to Young et al. and 5,099,864 to Young et al. (iii) a reconstituted tobacco material described in U.S. Pat. No. 4,962,774 to Thomasson et al. and *Tobacco Encyclopedia*, edited by Voges, p. 389, TJI (1984), (iv) the reconstituted tobacco materials described in U.S. Pat. Nos. 5,056,537 to Brown et al. and 5,074,321 to Gentry et al. or blends thereof.

The substrate materials of the present invention can be cased and top dressed as is conventional during various stages of cigarette manufacture. For example, flavoring agents can be applied to the substrate material as is commonly performed when cigarette cut filler is processed. Suitable flavoring agents include vanilla, cocoa, licorice, menthol, and the like. Flavor modifying agents can be applied to the substrate material. A flavor modifying agent in the form of levulinic acid can be applied to the substrate composition (e.g., in amounts ranging from about 0.01 to about 2 percent, normally from about 0.2 to about 0.6 percent based on the dry weight of the substrate material). Another flavor modifying agent in the form of potassium carbonate can be applied to the substrate material (e.g., in amounts of less than about 5 percent normally about 2 to about 3 percent based on the dry weight of the substrate material).

Aerosol forming materials and humectants such as glycerin and propylene glycol can be applied to the substrate material after formation. Such components may be applied to the substrate composition in the manner conventionally used to apply casing and top dressing components, but in any desired amount. While not wishing to be bound by theory, it is believed that such additional casing or top dressing-type components, over time, can be come bound or stabilized by the binder on or in the substrate.

The remaining components of the cigarette (or smoking article) also advantageously contain one or more forms of tobacco. For instance, tobacco can be incorporated into and/or around the fuel element. Similarly, tobacco can be positioned within the mouthend piece in a variety of fashions so that various flavorful tobacco components are transferred to the aerosol. The type and form of tobacco employed in these various segments of the smoking article can vary, and includes flue-cured, Burley, Maryland and Oriental tobaccos, the rare and specialty tobaccos, as well as blends thereof.

The fuel elements employed herein should meet three criteria; (1) they should be easy to ignite, (2) they should supply enough heat to produce aerosol for about 5–15, preferably about 8–12 puffs; and (3) they should not contribute off-taste or unpleasant aromas to the cigarette. Fuel elements prepared from a combustible composition comprising carbon and a binder, or carbon, tobacco and a binder are preferred, but other combustible compositions may be used.

If desired, a non-burning filler material such as calcium carbonate, agglomerated calcium carbonate, or the like, may be added to the fuel composition to assist

in controlling the calories generated by the fuel element during combustion, by reducing the amount of combustible material present therein. The filler material typically comprises less than about 50 weight percent of the fuel composition, preferably less than about 30 weight percent, and most preferably from about 5 to about 20 weight percent. See, U.S. patent application Ser. No. 07/567,520, filed Aug. 15, 1990.

Preferred fuel elements used herein comprise carbonaceous materials. The preferred carbonaceous materials have a carbon content above about 60 weight percent, more preferably above about 70 weight percent, and most preferably above about 80 weight percent. Flavors, tobacco materials, fillers (e.g. clays or calcium carbonate), burn additives, combustion modifying agents, and the like, may be incorporated into the fuel element.

The density of the preferred fuel elements is generally greater that about 0.5 g/cc, preferably greater than about 0.7 g/cc and most preferably greater than about 1 g/cc, but typically does not exceed 2 g/cc. The length of the fuel element, prior to burning, is generally less than about 25 mm, often less than about 17 mm, and is typically about 10–12 mm or less.

Exemplary compositions of carbonaceous fuel elements are set forth in U.S. Pat. Nos. 4,714,082 to Banerjee et al.; as well as in European Patent Publication Nos. 236,992 and 407,892; which are incorporated herein by reference. Other exemplary carbonaceous materials are coconut hull carbons, such as the PXC carbons and the PCB carbons, as well as the experimental carbons available as Lot B-11030-CAC-5, Lot B-11250-CAC-115 and Lot 089-A12-CAC-45, from Calgon Carbon Corp.

Other fuel elements can be provided from comminuted tobacco material, reconstituted tobacco material, heat treated or pyrolyzed tobacco materials, cellulosic materials, modified cellulosic materials, and the like. Exemplary materials are set forth in U.S. Pat. No. 3,931,824 to Miano et al., as well as in U.S. patent application Ser. No. 07/569,325, filed, Aug. 17, 1990, and in Sittig, *Tobacco Substitutes*, Noyes Data Corp. (1976).

One suitable fuel composition comprises from about 60 to about 99 weight percent carbon; from about 1 to about 20 weight percent of a suitable binder; from about 1 to about 5 weight percent of an ammonia releasing compound; and from about 2000 to about 20,000 ppm sodium (Na) as measured using inductively coupled plasma atomic emission spectroscopy (ICP-AES). Compounds capable of releasing ammonia under the burning conditions of the fuel composition include compounds such as urea, inorganic and organic salts (e.g., ammonium carbonate, ammonium alginate, or. mono-, di-, or tri-ammonium phosphate); amino sugars (e.g., prolino fructose or asparigino fructose); amino acids, particularly alpha amino acids (e.g., glutamine, glycine, asparagine, proline, alanine, cystine, aspartic acid, phenylalanine or glutamic acid); di-, or tri-peptides; quaternary ammonium compounds, and the like. These fuel compositions are described in detail in Riggs et al., U.S. patent application Ser. No. 07/722,993, filed Jun. 28, 1991, the disclosure of which is hereby incorporated herein by reference.

The carbonaceous fuel elements for smoking articles of the present invention may be molded, machined, pressure formed or extruded into the desired shape. Molded fuel elements can have channels, slots, grooves or hollow regions therein.

Preferred extruded carbonaceous fuel elements can be prepared by admixing up to 95 parts carbonaceous material, up to 20 parts binder and up to 20 parts tobacco (e.g., tobacco dust and/or a tobacco extract) with sufficient water (or aqueous Na_2CO_3 solution) to provide an extrudable mixture. This mixture can then be extruded using a ram, screw or piston type extruder into an extrudate of the desired shape having the desired number of channels or void spaces.

If desired, the fuel element can be at least partially circumscribed by a liner, such as at least one layer of paper, which surrounds the peripheral length of the fuel element (see FIG. 2). As such, the liner is positioned between the fuel element and the inner surface of the insulating and retaining material. Preferably, the one or two layers of liner extend along the length of the inner surface of the insulating and retaining material. Most preferably, the liner completely circumscribes the fuel element and extends along the total length of the inner surface of the insulating and retaining member. The liner most preferably is a tobacco paper (e.g., a tobacco/wood pulp paper available as P-2831-189-AA from Kimberly-Clark) or a carbon containing paper (e.g., a carbon—wood pulp—tobacco stem paper available as P-2540-136E from Kimberly-Clark).

When employed in a cigarette, the fuel element (with or without a liner) is circumscribed by an insulating and/or retaining jacket material. The insulating and retaining material preferably (i) is adapted such that drawn air can pass therethrough, and (ii) is positioned and configured so as to hold the fuel element in place. In some embodiments, the insulating and/or retaining material is compressed around the fuel element, thereby ensuring a good, stable positioning and snug fit of the fuel element therein.

In the cigarettes of the present invention, the fuel element may be recessed within the insulating and/or retaining jacket. The length of the jacket extending beyond each end of the fuel element may be as long or as short as desired for producing various burning and heat transfer characteristics. The jacket may be flush with the ends of the fuel element or it may extend from about 0.5 mm to about 3 mm, preferably from about 1 to 2.5, and most preferably from about 1.5 to 2 mm beyond each end of the fuel element.

The components of the insulating and/or retaining material which surrounds the fuel element can vary. This material is preferably one which has a tendency not to combust or a material which combusts but does not disintegrate. Examples of suitable materials include glass fibers and other materials of the type described in U.S. Pat. No. 5,105,838 to White et al. European Patent Publication No. 339,690; and pages 48–52 of the RJR Monograph, supra.

Examples of other suitable insulating and/or retaining materials are glass fiber and tobacco mixtures such as are described in U.S. Pat. No. 4,756,318 to Clearman et al. and U.S. Pat. Nos. 5,065,776 to Lawson et al. and 5,105,838 to White et al.

Other suitable insulating and/or retaining materials are gathered paper-type materials which are spirally wrapped or otherwise wound around the fuel element. Suitable paper-type materials include treated papers; papers containing carbonaceous materials; tobacco-containing papers; wood pulp papers; sulfate papers; wood pulp/calcium carbonate containing papers; papers containing carbonaceous materials, wood pulp, tobacco and fillers, such as those described in copending U.S.

Pat. No. 3,105,836 to Gentry et al. The paper-type materials can be gathered or crimped and gathered around the fuel element; gathered into a rod using a rod making unit available as CU-10 or CU2OS from Decoufle s.a.r.b., together with a KDF-2 rod making apparatus from Hauni-Werke Korber & Co., KG, or the apparatus described in U.S. Pat. No. 4,807,809 to Pryor et al.; wound around the fuel element about the longitudinal axis of the fuel element; or provided as longitudinally extending strands of paper-type sheet using the types of apparatus described in U.S. Pat. Nos. 4,889,143 to Pryor et al. and 5,025,814 to Raker, the disclosures of which are incorporated herein by reference.

Examples of paper-type sheet materials are available as P-2540-136-E carbon paper and P-2674-157 tobacco paper from Kimberly-Clark Corp.; and preferably the longitudinally extending strands of such materials (e.g., strands of about 1/32 inch width) extend along the longitude of the fuel element. The fuel element also can be circumscribed by tobacco cut filler (e.g., flue-cured tobacco cut filler treated with about 2 weight percent potassium carbonate). The number and positioning of the strands or the pattern of the gathered paper is sufficiently tight to maintain, retain or otherwise hold the fuel element within the cigarette.

As illustrated in FIGS. 1-3, the insulating and/or retaining material which surrounds the fuel element is circumscribed by a paper wrapper. This paper wrapper may comprise one or two layers, which may vary in air permeability and ash stability characteristics. Papers having these characteristics are described in U.S. Pat. No. 4,938,238 to Barnes et al. and U.S. Pat. No. 5,105,837 to Barnes et al. One example of a suitable paper wrapper is available as P-850-63-5 from Kimberly-Clark Corp. A portion of this wrapper is in turn circumscribed by a second or outer paper wrapper. An example of a suitable outer paper wrapper is available as P-850-61-2 from Kimberly-Clark Corp. Another suitable paper wrapper is available as P-3122-153 from Kimberly-Clark Corp.

The outer paper wrapper most preferably is a paper which exhibits a propensity not to burn (i.e., due to a very low porosity and/or due to chemical treatment), and preferably does not circumscribe the inner paper wrapper(s) for a length of about 2 mm to about 8 mm, more preferably about 3 mm to about 6 mm, from the extreme lighting end of the cigarette. The outer paper wrapper also circumscribes at least a portion of the length of the aerosol generating means. The outer wrapper acts to assist in preventing the fuel element from burning to any significant degree beyond its forward end. If necessary or desired, the papers employed near the fuel element, particularly those paper wrappers which are positioned outward from the non-burning portion of the fuel element can be coated with burn retardants, such as aqueous solutions of calcium chloride or diammonium hydrogen orthophosphate.

In most embodiments of the present invention, the combination of the fuel element and the substrate (also known as the front end assembly) is attached to a mouthend piece; although a disposable fuel element-/substrate combination can be employed with a separate mouthend piece, such as a reusable cigarette holder. The mouthend piece provides a passageway which channels vaporized aerosol forming materials into the mouth of the smoker; and can also provide further flavor to the vaporized aerosol forming materials. Typically, the length of the mouthend piece ranges form 40 mm to about 85 mm.

Advantageously, the length of the mouthend piece is such that (i) the burning portion of the fuel element is kept well away from the fingers of the smoker; and (ii) hot vaporized aerosol forming materials have sufficient time to cool before reaching the mouth of the smoker. It is often highly desirable to provide a void space within the mouthend piece immediately behind the aerosol generating means. For example, a void space extending at least about 10 mm along the length of the smoking article may be provided immediately behind the aerosol generating means and forward of any tobacco cut filler, tobacco paper or filter segments.

A segment of gathered tobacco paper or tobacco cut filler (or the like) can be incorporated in the mouthend piece. Such a segment can be positioned directly behind the substrate or spaced apart therefrom. A segment of gathered carbon paper can be incorporated into the mouthend piece, particularly in order to introduce menthol flavor to the aerosol. Suitable gathered carbon paper segments are described in European Patent Publication No. 432,538. If desired, a segment including a gathered web of non-woven polypropylene or polyester in intimate contact with a water soluble tobacco extract can be incorporated into the mouthend piece. Such a segment is described in U.S. Pat. Nos. 5,076,295 to Saintsing and 5,105,834 to Saintsing et al.

Suitable mouthend pieces normally are inert With respect to the aerosol forming material, offer minimum aerosol loss as a result of condensation or filtration, and are capable of withstanding the temperatures experienced using use of the smoking article. Exemplary mouthend pieces include plasticized cellulose acetate tubes, such as is available as SCS-1 from American Filtrona Corp.; polyimide tubes available as Kapton from E. I. dupont de Nemours; paperboard or heavy paper tubes; and aluminum foil-lined paper tubes.

The tubular mouthend piece is positioned in an abutting end-to-end relationship with the front end assembly of the cigarette, i.e., the fuel element and substrate combination. Preferably, the cross-sectional shape and dimensions of the mouthend piece are essentially identical to those of the front end assembly. The front end assembly and the combination of the mouthend segments are attached to one another using a circumscribing tipping paper.

The extreme mouth end region of the smoking article preferably includes a filter element or tip, partially for aesthetic reasons. Preferred filter elements are low efficiency filter elements which do not interfere appreciably with aerosol yields. Suitable filter low efficiency filter elements which do not interfere appreciably with aerosol yields. Suitable filter materials include low efficiency cellulose acetate or polypropylene tow, baffled or hollow molded polypropylene materials, gathered webs of non-woven polypropylene materials, or gathered webs of cellulose acetate or paper. Suitable filter elements can be provided by gathering a non-woven polypropylene web available as PP-100-F from Kimberly-Clark Corp. using the filter rod forming apparatus described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor et al.

The entire length of the smoking article, or any portion thereof, can be overwrapped with cigarette paper. Preferred papers of the FIG. 1 type cigarettes, e.g., which circumscribe the heat conducting member, should not openly flame during use of the smoking

article, should have controllable smolder properties, and should produce a gray ash. Exemplary, cigarette papers of this type are described in U.S. Pat. No. 4,779,631 to Durocher et al. and European Patent Publication No. 304,766. Suitable paper wrappers are available as P-1981-152, P-1981-124 and P-1224-63 from Kimberly-Clark Corp. Suitable papers for the FIG. 2 and 3 type cigarettes include Kimberly-Clark's P-2831-189-AA and P-3122-153. Tipping paper can circumscribe the extreme mouth end of the smoking article. Suitable tipping papers are non-porous tipping papers treated with "non-lipsticking" materials, and such papers will be apparent to the skilled artisan.

The present invention will be further illustrated with reference to the following examples which aid in the understanding of the present invention, but which are not to be construed as limitations thereof. All percentages reported herein, unless otherwise specified, are percent by weight. All temperatures are expressed in degrees Celsius.

EXAMPLE 1

GENERAL TECHNIQUES

The stabilized substrate compositions of the present invention are prepared by the following general techniques.

The binder, e.g., ammonium alginate, is first admixed with an excess amount of water (e.g., about 70:1 (parts) water to binder, for approximately five minutes, to fully hydrate the same. Next, the aerosol forming material, or mixture of such materials, e.g., glycerin and optional flavorants, is added to the aqueous algiinate slurry, and stirred to blend the same intimately. If ammonium alginate is employed as the binder, one or more sequestering agents, e.g., aqueous K_2CO_3, or the like, may be added to the slurry, if necessary or desired. Finally, dry ingredients, which may be first blended together (if desired) are added, e.g., precipitated $CaCO_3$ and/or tobacco. Stirring is continued to form an intimate admixture, in aqueous slurry form.

The final slurry may be further diluted with water to form a sprayable or printable mixture. Such mixtures are then applied to appropriate substrate base materials, e.g., tobacco cut filler, tobacco paper sheets, and the like. If desired, the undiluted slurry may be cast onto an appropriate surface, e.g., a high density polyethylene sheet, in strips of about 2 inches ×3 inches (50.8 mm×76 mm) at at thickness ranging from about 0.010 to 0.080 inches (about 0.25 mm to 2.0 mm) and air dried. The resulting cast sheet may be shredded, e.g., at about 32 cuts per inch, and used as a substrate, e.g., in cut filler form, or blended with tobacco cut filler or other substrate materials to form a final substrate.

EXAMPLE 2

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	6.0 wt. percent
glycerin	45.0 wt. percent
K_2CO_3	1.0 wt. percent
$CaCO_3$	3.0 wt. percent
tobacco (American blend)	45.0 wt. percent

This slurry is cast at a thickness of about 0.04 inches (about 1 mm) onto a polyethylene sheet, air dried, and cut into strips resembling tobacco cut filler. The substrate material is overwrapped with a circumscribing paper wrapper and cut into segments having a diameter of 7.5 mm and a lengths of 10 or 15 mm, both useful as substrates.

EXAMPLE 3

A stabilized substrate composition is prepared in a two step method, by first spray applying 30.5 parts of a 1:1 water glycerin solution onto 69.5 parts reconstructed tobacco cut filler. The treated tobacco is then dried using a laboratory Master Heat Gun (Model No. HG-75/B from the Master Appliance Corp. of Racine, Wis.) at an air temperature of about 90° C. for sufficient time to provide a final moisture content of from about 12–15%.

Subsequently, a binder solution consisting of a 99:1 aqueous ammonium alginate (Kelco Co. Amoloid LV) is spray applied to the dried tobacco to yield a substrate product consisting of 1 part binder and 99 parts tobacco and glycerin (based on dry weight). This mixture is dried with the Master Heat Gun at an air temperature of about 90° C. to a produce a substrate composition having a final moisture content of from about 8–12%.

EXAMPLE 4

A stabilized substrate is prepared in a one step method by spray applying an aqueous mixture consisting of 30 parts glycerin and 1 part Amoloid LV ammonium alginate binder (with sufficient water to make a sprayable mixture) onto 69 parts American blend tobacco cut filler. The treated tobacco is then dried using a laboratory Master Heat Gun at an air temperature of about 90° C. for sufficient time to provide a substrate composition having a final moisture content of from about 8–12%.

EXAMPLE 5

A. The two-step procedure of Example 3 is repeated, using volume expanded tobacco as the substrate base material, to form a substrate composition consisting of 30 parts glycerin, 1 part Amoloid LV binder and 69 parts tobacco.

B. The one-step procedure of Example 4 is repeated, using volume expanded tobacco as the substrate base material, to form a substrate composition consisting of 30 parts glycerin, 1 part Amoloid LV binder and 69 parts tobacco.

EXAMPLE 6

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	11 wt. percent
glycerin	89 wt. percent

This slurry is printed onto a sheet of Kimberly-Clark's P3122-109-A16 tobacco paper to a final loading of about 140 percent by weight. The printed paper is dried with heated air (up to about 90° C.), to remove excess moisture, to provide a substrate composition having a final moisture content of about 8–12%.

The substrate material is overwrapped with a circumscribing paper wrapper and cut into segments having a diameter of about 7.5 mm and lengths of 10 and 15 mm, both suitable for use as substrates herein.

EXAMPLE 7

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	10 wt. percent
flavor	18 wt. percent
glycerin	72 wt. percent

This slurry is printed onto a sheet of Kimberly-Clark's P3122-109-A16 tobacco paper to a final loading of about 140 percent by weight. The printed paper is dried with heated air (up to about 90° C. air temperature), to remove excess moisture, yielding a substrate composition having a final moisture content of about 8–12%.

The substrate material is overwrapped with a circumscribing paper wrapper and cut into segments having a diameter of about 7.5 mm and lengths of 10 and 5 mm, both suitable for use as substrates herein.

EXAMPLE 8

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	6 wt. percent
glycerin	35 wt. percent
$CaCO_3$	23 wt. percent
tobacco (American blend)	35 wt. percent
K_2CO_3	1 wt. percent

This slurry is cast at a thickness of about 0.03 inches (about 0.76 mm) onto a polyethylene sheet, air dried, and cut into strips resembling tobacco cut filler. This substrate composition is overwrapped with a circumscribing paper wrapper to a diameter of 7.5 mm and cut into segments having lengths of 10 or 15, both useful as substrates.

EXAMPLE 9

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	9.8 wt. percent
glycerin	39.0 wt. percent
$CaCO_3$	20.0 wt. percent
tobacco (American blend)	31.2 wt. percent

The slurry is cast at a thickness of about 0.04 inch (about 1 mm) and air dried. This substrate composition can be shredded into cut filler or made into a gathered web. This composition as cut filler or gathered web can be made into 7.5 mm diameter paper wrapped rods and cut into 10 mm sections to be used as substrates.

EXAMPLE 10

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	6.0 wt. percent
glycerin	60.0 wt. percent
$CaCO_3$	3.0 wt. percent
ball milled tobacco	

-continued

American blend diammonium hydrogen	25.0 wt. percent
phosphate	1.0 wt. percent
flavor (see Ex. 7)	5.0 wt. percent

The slurry is cast at a thickness of about 0.04 inch (about 1 mm) and air dried. This substrate composition is shredded into cut filler and made into rods having a diameter of 7.5 mm and a length of 10 or 27 mm, both of which are useful as substrates.

EXAMPLE 11

An aqueous slurry is prepared from the following ingredients:

glycerin	80 wt. percent
Kelco HV	20 wt. percent

Two segments of paper, Kimberly-Clark's P1976-29-2, are cast with 370% and 375% by weight of the slurry (on dry weight basis). The cast sheets are dried at 50° C. overnight to afford a substrate composition which can be rolled, cut, or shredded into strips for use as substrates.

EXAMPLE 12

An aqueous slurry is prepared from the following ingredients:

glycerin	80 wt. percent
Kelco HV	20 wt. percent

Two segments of reconstituted tobacco sheet, Kimberly-Clark's P3122-109-A15, are cast with 320% and 240% by weight of the slurry (on dry weight basis). The cast sheets are dried at 50° C. overnight to afford a substrate composition which can be rolled, cut, or shredded into strips for use as substrates.

EXAMPLE 13

An aqueous slurry is prepared from the following ingredients:

glycerin	80 wt. percent
Kelco HV	20 wt. percent

A segment of aluminum foil is cast with 109% by weight of the slurry (on dry weight basis). The cast sheet is dried at 50° C. overnight to afford a substrate composition which can be rolled, cut, or shredded into strips for use as substrates.

EXAMPLE 14

An aqueous slurry is prepared from the following ingredients:

ammonium alginate Kelco HV	13.5 parts by wt.
glycerin	81.0 parts by wt.
PCB-G carbon with 30% menthol	5.5 parts by wt.

The carbon/menthol mixture is prepared by ball milling PCB-G activated carbon from Calgon Carbon

Corp., Pittsburgh, Pa., with 30 wt. percent solid menthol. During the ball milling process the mixture becomes warm, which causes the menthol to vaporize, and the activated carbon adsorbs and/or absorbs the menthol vapors.

The slurry is cast at a thickness of about 0.04 inch (about 1 mm) onto Kimberly Clark's No. P-3122-109-A16 paper and air dried under ambient conditions to drive off excess moisture. This substrate composition can be shredded into cut filler or made into a gathered web. This composition as cut filler or gathered web can be made into 7.5 mm diameter paper wrapped rods and cut into 10 mm sections to be used as substrates.

EXAMPLE 15

An aqueous slurry based on a ratio of 4 parts water to one part solids is prepared in the following manner:

Water at 180° F. (about 82° C.) is added to a high sheer mixer. Tobacco solids at 61.3 weight percent (containing 10% moisture) are added to the water and thoroughly mixed therewith. Next, 3.8 weight percent dibasic diammonium phosphate is added to the mixture, which is stirred (digested) for 30–45 minutes. Then, 4.2 weight percent of a 30% aqueous ammonium hydroxide solution is added and mixed (digested) for another 30–45 minutes. Finally, 30.7 weight percent glycerin is added and the mixture is stirred an additional 10–15 minutes.

The resulting slurry is cast on a stainless steel belt at a thickness of 0.03 inches (about 0.76 mm) to form a sheet. Air at 200° F. (about 93° C.) is blown over the upper surface of the sheet while steam contacts the underside of the stainless steel belt. The combined heating methods dry the sheet without driving off the aerosol forming materials. The sheet is doctored off the belt. The film may be shredded into cut filler or made into a gathered web, then overwrapped with paper and cut into 7.5 mm diameter by 10–15 mm long substrate sections.

EXAMPLE 16

Example 15 is repeated, with the following ingredients:

glycerin	47 weight percent
tobacco solids	47 weight percent
diammonium phosphate dibasic	3 weight percent
30% ammonium hydroxide	3 weight percent

EXAMPLE 17

An aqueous slurry based on a ratio of 4 parts water to one part solids is prepared in the following manner:

Water heated to about 180° F. (about 82° C.) is added to a high sheer mixer. Tobacco solids at 32 weight percent (containing 10% moisture) is added to the water and thoroughly mixed therewith. Next, 2 weight percent dibasic diammonium phosphate is added to the mixture, which is stirred for 30–45 minutes. Then, 2 weight percent of a 30% aqueous ammonium hydroxide solution is added and mixed for 30–45 minutes.

Ammonium alginate (Kelco HV) at 4 weight percent is activated in 180° F. (about 82° C.) water at a 1:15 solids to water ratio.

Glycerin at 60 weight percent is added to the tobacco slurry, followed by the activated ammonium alginate. This mixture is stirred at high shear for 10–15 minutes.

This slurry is cast on a stainless steel belt at a thickness of 0.03 inches (about 0.76 mm) to form a sheet. Air at 200° F. (about 93° C.) is blown over the upper surface of the sheet while steam contacts the underside of the stainless steel belt. The combined heating methods dry the sheet without driving off the aerosol forming materials. The sheet is doctored off the belt. The film may be shredded into cut filler or made into a gathered web, then overwrapped with paper and cut into 7.5 mm diameter by 10–15 mm long substrate sections.

EXAMPLE 17

Example 16 is repeated, with the following ingredients:

glycerin	60 weight percent
tobacco solids	30 weight percent
diammonium phosphate dibasic	2 weight percent
30% ammonium hydroxide	2 weight percent
Kelco HV	6 weight percent

EXAMPLE 18

CIGARETTE OF FIG. 1

Fuel Element Preparation

A generally cylindrical fuel element 9 mm long and 4.5 mm in diameter, and having an apparent (bulk) density of about 1.02 g/cc is prepared from about 72 parts hardwood pulp carbon having an average particle size of 12 microns in diameter, about 20 parts of blended tobacco dust including Burley, flue cured and oriental, the dust being approximately 200 Tyler mesh, and 8 parts Hercules 7HF SCMC binder.

The hardwood pulp carbon is prepared by carbonizing a non-talc containing grade of Grande Prairie Canadian kraft hardwood paper under nitrogen blanket, increasing the temperature in a step-wise manner sufficient to minimize oxidation of the paper, to a final carbonizing temperature of at least 750° C. The resulting carbon material is cooled under nitrogen to less than 35° C., and then ground to fine power having an average particle size of about 12 microns in diameter.

The finely powdered hardwood carbon is admixed with the tobacco dust, the sodium carboxymethyl cellulose binder, and sufficient water to provide a mixture having a stiff, dough-like paste form.

Fuel elements are extruded using a ram extruder from the paste so as to have 5 equally spaced peripheral slots or grooves, each having a depth of about 0.032 inch and a width of about 0.016 inch. The configuration of the passageways which extend longitudinally through the fuel element is shown in FIG. 1A. The resulting extrudate is dried in air to provide a resilient extrudate, and the extrudate is cut into 9 mm lengths, thereby providing fuel elements.

Substrate and Sleeve Assembly

A metal capsule is manufactured from aluminum using a metal drawing process. The capsule has a length of about 30 mm, an outer diameter of about 4.6 mm, and an inner diameter of about 4.4 mm. One end of the capsule (the fuel element end) is open; and the other end is closed, except for two slot like openings. The closed

nd of the capsule is modified to have a single opening about 4 mm in diameter, thereby converting the capsule into a sleeve.

A rod of tobacco cut filler, prepared from the substrate composition described in Example 3, about 4.4 mm in diameter and about 15 mm long is placed in the sleeve, and positioned toward the rear thereof, at least about 4 to 5 mm from the open end (i.e., the front end).

A fuel element is then inserted into the front end of the sleeve to a depth of about 2 mm. As such, the fuel element extends about 7 mm beyond the open end of the sleeve, and the substrate is separated from the rear of the fuel element by about 2 to 3 mm.

Insulating Jacket

A 15 mm long, 4.5 mm diameter plastic tube is overwrapped with an insulating jacket material that is also 15 mm in length. In these cigarette embodiments, the insulating jacket is composed of 2 layers of Owens-Corning C-glass mat, each about 1 mm thick prior to being compressed by the jacket forming machine, and after formation, each being about 0.6 mm thick. Sandwiched between the two layers of C-glass is one sheet of reconstituted tobacco paper, about 0.13 mm thick, and a second sheet of 0.13 mm thick reconstituted tobacco paper overwraps the outer layer of glass. The reconstituted tobacco paper sheet, designated P2674-157 from Kimberly-Clark Corp., is a paper-like sheet containing a blended tobacco extract. The width of the reconstituted tobacco sheets prior to forming are 19 mm for the inner sheet and 26.5 mm for the outer sheet. The final diameter of the jacketed plastic tube is about 7.5 mm.

Tobacco Roll

A tobacco roll consisting of volume expanded blend of Burley, flue cured and oriental tobacco cut filler is wrapped in a paper designated as P1487-125 from Kimberly-Clark Corp., thereby forming a tobacco roll having a diameter of about 7.5 mm and a length of about 22 mm. See U.S. Pat. No. 5,095,922 to Johnson et al. for a preferred volume expanded tobacco process.

Front End Assembly

The insulating jacket section and the tobacco rod are joined together by a paper overwrap designated as P2674-190 from Kimberly-Clark Corp., which circumscribes the length of the tobacco/glass jacket section as well as the length of the tobacco roll. The mouth end of the tobacco roll is drilled to create a longitudinal passageway therethrough of about 4.6 mm in diameter. The tip of the drill is shaped to enter and engage the plastic tube in the insulating jacket. The cartridge assembly is inserted from the front end of the combined insulating jacket and tobacco roll, simultaneously as the drill and the engaged plastic tube are withdrawn from the mouth end of the roll. The cartridge assembly is inserted until the lighting end of the fuel element is flush with the front end of the insulating jacket. The overall length of the resulting front end assembly is about 37 mm.

Mouthend Piece

The mouthend piece includes a 20 mm long cylindrical segment of a loosely gathered tobacco paper and a 20 mm long cylindrical segment of a gathered web of non-woven, melt-blown polypropylene, each of which includes an outer paper wrap. Each of the segments are provided by subdividing rods prepared using the apparatus described U.S. Pat. No. 4,807,809 to Pryor et al.

The first segment is about 7.5 mm in diameter, and is provided from a loosely gathered web of tobacco paper available as P1440-GNA from Kimberly-Clark Corp. which is circumscribed by a paper plug wrap available as P1487-184-2 from Kimberly-Clark Corp.

The second segment is about 7.5 mm in diameter, and is provided from a gathered web of non-woven polypropylene available as PP-100 from Kimberly-Clark Corp. which is circumscribed by a paper plug wrap available as P1487-184-2 from Kimberly-Clark Corp.

The two segments are axially aligned in an abutting end-to-end relationship, and are combined by circumscribing the length of each of the segments with a paper overwrap available as L-1377-196F from Simpson Paper Company, Vicksburg, Mich. The length of the mouthend piece is about 40 mm.

Final Assembly of Cigarette

The front end assembly is axially aligned in an abutting end-to-end relationship with the mouthend piece, such that the container end of the front end assembly is adjacent to the gathered tobacco paper segment of the mouthend piece. The front end assembly is joined to the mouthend piece by circumscribing the length of the mouthend piece and a 5 mm length of the front end assembly adjacent the mouthend piece with tipping paper.

Use

In use, the smoker lights the fuel element with a cigarette lighter and the fuel element burns. The smoker inserts the mouth end of the cigarette into his/her lips, and draws on the cigarette. The drawn hot air from the fuel element passes through the substrate and volatilizes the stabilized aerosol former, releasing it from the binder. As the volatile materials are drawn toward the smokers mouth, they pick up flavors from the tobacco segments, and also cool, forming a flavorful, visible, smoke-like aerosol. This visible aerosol having tobacco flavor is drawn into the mouth of the smoker.

EXAMPLE 19

CIGARETTE OF FIG. 2

Fuel Element Preparation

A symmetrical fuel element having the configuration substantially of that shown in FIG. 2 is prepared as follows:

A generally cylindrical longitudinally segmented fuel element 12 mm long and 4.8 mm in diameter, and having an apparent (bulk) density of about 1.02 g/cc is prepared from about 89.1 parts hardwood pulp carbon having an average particle size of 12 microns in diameter, 10 parts ammonium alginate (Amoloid HV, Kelco Co.) and 0.9 parts Na_2CO_3.

The hardwood pulp carbon is prepared by carbonizing a non-talc containing grade of Grande Prairie Canadian kraft hardwood paper under nitrogen blanket, increasing the temperature in a step-wise manner sufficient to minimize oxidation of the paper, to a final carbonizing temperature of at least 750° C. The resulting carbon material is cooled under nitrogen to less than 35° C., and then ground to fine power having an average particle size of about 12 microns in diameter.

The finely powdered hardwood carbon is dry mixed with the alginate binder, and then an 3% percent aque-

ous solution of sodium carbonate is added to provide an extrudable mixture, having a final Na_2CO_3 content of 0.9 parts by weight.

Cylindrical fuel rods (each about 24 inches long) are extruded using a screw extruder from the mixture having a generally cylindrical shape about 4.8 mm in diameter, with six (6) equally spaced peripheral grooves (about 1 mm×1 mm) with rounded bottoms, running from end to end. The extruded rods have an initial moisture level ranging from about 32–34 weight percent. They are dried at ambient temperature for about 16 hours and the final moisture content is about 7–8 weight percent.

The dried cylindrical rods are end trimmed to a length of 22.5 inches using diamond tipped steel cutting wheels. The rods are placed into a rotating drum having a plurality of channels adapted for accepting and retaining each fuel rod. The rods are secured into the channels on the drum by a plurality of thin rubber straps. The drum is rotated past a shaft having a series of spaced, thin, circular, diamond tipped steel blades. Exemplary blades are the 4-inch diameter 100 to 120 grit blades available from the Norton Co. as 1AIR. The blades are positioned on a shaft so as to create the isolation segments along the length of each rod and trim the rod to the correct length for the next operation. The dimensions of the isolation segments are provided by movement of the shaft or by the use of a wobble plate. The drum continues to rotate and the rod is released therefrom.

The cut rod is then placed into another rotating drum having a plurality of channels adapted for accepting and retaining the rod. The rods are secured in the channels on the drum by a plurality of thin rubber straps. The drum is rotated past a shaft having a series of spaced diamond tipped blades positioned to cut through the rod in the desired locations, forming individual fuel elements. The drum continues to rotate to release the cut fuel elements therefrom into a collection bin.

The finished fuel elements are each 12 mm in length, having end segment lengths of 2.5 mm, two isolation segments 1.5 mm in length each, and an intermediate segment 4.0 mm in length. As such, the cross-sectional area of the isolation segments is about 49% of the cross-sectional area of the end segments. Each fuel element weighs about 165 mg.

Front End Preparation

The fuel element is circumscribed by Owens-Corning C-glass fibers. For details regarding the properties of this material see pages 48–52 of the RJR Monograph, supra. The glass fibers are in turn circumscribed by a paper wrapper available from Kimberly-Clark Corp. as P-2831-189-AA, providing a cylinder having open ends for the passage of air therethrough, a length of about 16 mm and a circumference of about 7.5 mm.

Substrate

Any of the substrates identified in Examples 1–13 may be successfully employed herein. One especially preferred substrate is set forth in Example 9.

Mouthend Piece

A paper tube of about 63 mm length and about 7.5 mm diameter is made from a web of paper about 27 mm wide. The paper is a 76 lb. basis weight paper having a thickness of about 0.012 inch, which is available from Simpson Paper Co. as RJR-001. The paper is formed into a tube by lap-joining the paper using a water-based ethylene vinyl acetate adhesive. To prevent any possible aerosol former migration, the inner surface of the tube is coated with Hercon 70 from Hercules, Inc. about 10 mm into the tube and allowed to dry. Then, the once coated inner surface of the tube is again coated, but with an aqueous solution of calcium chloride (to prevent burning), and allowed to dry.

A 10 mm long substrate is inserted into the coated end of the paper tube such that the front face of the substrate is about 3 mm from the front end of the paper tube. The substrate is held in place securely within the paper tube by friction fit. A 10 mm long segment of tobacco cut filler, wrapped in a circumscribing paper wrapper is inserted into the opposite end of the tube. This tobacco segment is pushed into the tube so that the back end of the tobacco is about 10 mm from the extreme mouth end of the tube.

Into the end of the paper tube opposite the substrate is inserted a cylindrical filter element so as to abut the segment of tobacco cut filler. The filter element has a length of about 10 mm and a circumference of about 24 mm. The filter element is provided using known filter making techniques from triacetin plasticized cellulose acetate tow (8.0 denier per filament; 40,000 total denier), and circumscribing paper plug wrap.

Assembly of the Cigarette

The mouthend piece and front end are positioned in an abutting, end-to-end relationship, such that the front face of the substrate is positioned about 3 mm from the back face of the fuel element. The front end and mouthend pieces are held together by a circumscribing paper wrapper which acts as a tipping paper. The paper wrapper is a low porosity paper available as P-850-61-2 from Kimberly-Clark Corp., and circumscribes the entire length of the front end piece except for about a 3 mm length of the front end piece at the extreme lighting end thereof.

The cigarette is smoked, and yields visible aerosol and tobacco flavor (i.e., volatilized tobacco components) on all puffs for about 10–12 puffs. The fuel element burns to about the region thereof where the burning portion meets the isolation portion, and the cigarette self-extinguishes.

EXAMPLE 20

Fuel Element Preparation

A fuel element 12 mm long and 4.8 mm in diameter, and having an apparent (bulk) density of about 1.02 g/cc is prepared from about 78.7 parts hardwood pulp carbon having an average particle size of 12 microns in diameter, 10 parts ammonium alginate (Amoloid HV, Kelco Co.), 1.0 parts Na_2CO_3, 10 parts, ball-milled American blend tobacco and 0.3 parts tobacco extract, obtained as described in U.S. patent application Ser. No. 07/710,273, filed Jun. 9, 1991.

The hardwood pulp carbon is prepared by carbonizing a non-talc containing grade of Grande Prairie Canadian kraft hardwood paper under nitrogen blanket, increasing the temperature in a step-wise manner sufficient to minimize oxidation of the paper, to a final carbonizing temperature of at least 750° C. The resulting carbon material is cooled under nitrogen to less than 35° C., and then ground to fine power having an average particle size of about 12 microns in diameter.

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The finely powdered hardwood carbon is dry mixed with the ammonium alginate binder, and tobaccos, and then a 3% wt. percent aqueous solution of Na_2CO_3 is added to provide an extrudable mixture, having a final sodium carbonate level of about 1.0 parts.

Cylindrical fuel rods (each about 24 inches long) are extruded using a screw extruder from the mixture having a generally cylindrical shape about 4.8 mm in diameter, with five (5) equally spaced peripheral grooves (about 1 mm×1 mm) with rounded bottoms, running from end to end. The extruded rods have an initial moisture level ranging from about 32–34 weight percent. They are dried at ambient temperature for about 16 hours and the final moisture content is about 7–8 weight percent. The dried cylindrical rods are cut to a length of 12 mm using diamond tipped steel cutting wheels.

Insulating Jacket

A 16 mm long, 4.5 mm diameter plastic tube is overwrapped with an insulating jacket material that is also 16 mm in length. In these cigarette embodiments, the insulating jacket is composed of 2 layers of Owens-Corning C-glass mat, each about 1 mm thick prior to being compressed by the jacket forming machine, and after formation, each being about 0.6 mm thick. Sandwiched between the two layers of C-glass is one sheet of reconstituted tobacco paper, Kimberly-Clark's P-2831-189-AA, about 0.13 mm thick. A cigarette paper, designated P-3122-153 from Kimberly-Clark, overwraps the outer layer. The reconstituted tobacco paper sheet, is a paper-like sheet containing a blended tobacco extract. The width of the reconstituted tobacco sheets prior to forming are 19 mm for the inner sheet and 26.5 mm for the outer sheet. The final diameter of the jacketed plastic tube is about 7.5 mm.

Frontend Piece

A 12 mm long fuel element is inserted into the insulating jacket to force out the 16 mm long plastic tube. The fuel element is positioned in the jacket so that each end is recessed about 2 mm.

Substrate

Any of the substrates identified in Examples 1–13 may be successfully employed herein. One especially preferred substrate is set forth in Example 9.

Paper Tube

A paper tube about 77 mm length and about 7.5 mm diameter is made from a web of 76 pound basis weight Simpson RJR-001 paper, about 27 mm wide, having a thickness of about 0.012 inch. The RJR-001 paper is formed into a tube by lap-joining the paper using a water-based ethylene vinyl acetate adhesive. The inner surface of the paper tube is coated with a water-based ethylene vinyl acetate adhesive containing ethanol and phosphoric acid, together with the anti-mold preservative Kathon LX-1.5, available from Rohm and Haas. An aluminum foil sheet 37 mm in length is wrapped around a steel rod approximately 6.75 mm in outer diameter and inserted into the end of the paper tube so that one edge of the foil tube is flush with one edge of the paper tube. The steel rod is then removed, leaving the foil laminated to the inner surface of the paper tube.

Assembly of the Cigarette

A 15 mm long 7.5 mm diameter substrate is inserted into the foil-lined end of the paper tube such that the front face of the substrate is about 10 mm from the front end of the paper tube. The substrate is held in place securely within the paper tube by friction fit. A 12 mm long 7.5 mm diameter segment of reconstituted tobacco paper, wrapped in a circumscribing paper wrapper is inserted into the opposite end of the tube. This tobacco paper segment is pushed into the tube so that it abuts the back end of the substrate. Next, a 20 mm long 7.5 mm diameter segment of tobacco cut filler, wrapped in a circumscribing paper wrapper is inserted into the paper tube to abut the reconstituted tobacco paper segment. A 20 mm long 7.5 mm diameter polypropylene web filter element is inserted into the paper tube so that it abuts the segment of tobacco cut filler. A front end piece is inserted into the opposite end of the paper tube so that the internal end of the insulating jacket abuts the front end of the substrate. The front end piece extends outwardly at least about 6 mm from the front end of the paper tube.

The cigarette is smoked, and yields visible aerosol and tobacco flavor (i.e., volatilized tobacco components) on all puffs for about 10–12 puffs. The fuel element burns to about the region thereof where the burning portion meets the isolation portion, and the cigarette self-extinguishes.

The present invention has been described in detail, including the preferred embodiments thereof. However, it will be appreciated that those skilled in the art, upon consideration of the present disclosure, may make modifications and/or improvements on this invention and still be within the scope and spirit of this invention as set forth in the following claims.

What is claimed is:

1. A stabilized substrate composition, comprising an admixture of an aerosol forming substance, in an effective amount to provide a smokeable aerosol, and a binder which stabilizes the aerosol forming substance, wherein the ratio of the aerosol forming substance to the binder is in the range of from about 3:1 to about 40:1, and where the binder comprises an alginate binder.

2. The stabilized composition of claim 1, further comprising sufficient water to be a sprayable composition at room temperature.

3. The stabilized composition of claim 1, further comprising sufficient water to be a printable composition at room temperature.

4. The stabilized composition of claim 1, further comprising sufficient water to be an extrudable composition at room temperature.

5. The stabilized composition of claim 1, further comprising sufficient water to be a castable composition at room temperature.

6. The stabilized composition of claim 5, which further includes one or more sequestering agents.

7. The stabilized composition of claim 5, further comprising a filler material selected from the group consisting of inorganic fillers, organic fillers, and mixtures thereof.

8. The stabilized composition of claim 7, wherein the organic filler material comprises tobacco.

9. The stabilized composition of claim 7, wherein the filler material comprises a mixture of tobacco and an inorganic filler material.

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10. The stabilized composition of claim 7, wherein the organic filler material comprises carbon.

11. The stabilized composition of claim 10, wherein the organic filler material further comprises menthol.

12. The stabilized composition of claim 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, or 11, wherein the binder comprises one or more naturally occurring tobacco binders liberated by a cross-link destabilizing agent.

13. The stabilized substrate composition of claim 14, wherein the moisture content of the substrate composition is from about 8 to 12%.

14. The stabilized composition of claim 1, 2, or 3, further comprising a base material to which the stabilized composition has been applied, said base material being selected from the group consisting of organic-based and inorganic-based, mat, web, sheet, shredded, or cut filler materials.

15. The stabilized composition of claim 14, wherein the base material is an inorganic-based material selected from the group consisting of aluminum foil, plastic film, or glass fiber mat.

16. The stabilized composition of claim 14, wherein the base material is an organic-based paper material, in a sheet, mat, web, shredded, or cut filler form.

17. The stabilized composition of claim 14, wherein the organic based material is a paper containing wood pulp.

18. The stabilized composition of claim 14, wherein the organic based material is a paper containing tobacco.

19. A stabilized substrate composition, comprising tobacco cut filler as a base material to which has been applied an admixture comprising a polyhydric alcohol, in an effective amount to provide a smokeable aerosol, and a binder plasticizable by said polyhydric alcohol, wherein the ratio of the polyhydric alcohol to binder is from about 15:1 to about 40:1.

20. The stabilized composition of claim 19, wherein the ratio of polyhydric alcohol to binder is in the range of from about 25:1 to about 5:1.

21. A stabilized composition, comprising a reconstituted tobacco paper sheet as a base material to which has been applied an admixture comprising a polyhydric alcohol, in an effective amount to provide a smokeable aerosol, and a binder plasticizable by said polyhydric alcohol, wherein the ratio of the polyhydric alcohol to binder is from about 3:1 to about 15:1.

22. The stabilized composition of claim 21, wherein the ratio of polyhydric alcohol to binder is in about 10:1.

23. A stabilized substrate composition comprising a glass fiber mat as a base material to which has been applied an admixture comprising a polyhydric alcohol, in an effective amount to provide a smokeable aerosol, and a binder plasticizable by said polyhydric alcohol, wherein the ratio of the polyhydric alcohol to binder is from about 3:1 to about 15:1.

24. The stabilized composition of claim 25, wherein the ratio of polyhydric alcohol to binder is in about 10:1.

25. A stabilized substrate composition, comprising an admixture of a filler material, a polyhydric alcohol aerosol forming material, in an effective amount to provide a smokeable aerosol, and a binder, wherein the ratio of the polyhydric alcohol to the binder ranges from about 15:1 to about 40:1.

26. The stabilized composition of claim 25, wherein the filler material is selected from the group consisting of inorganic filler materials, organic filler materials, and mixtures thereof.

27. The stabilized composition of claim 25 or 26, wherein the filler material comprises tobacco.

28. The stabilized composition of claim 25 or 26, further including a base material with which the stabilized composition has been mixed, said base material being selected from the group consisting of sheet materials, shredded materials, and cut-filler materials.

29. The stabilized composition of claim 28, wherein the ratio of polyhydric alcohol to binder is from about 25:1 to 35:1.

30. A substrate for smoking articles, comprising a base material in the form of a sheet, mat, or webs said base material having a film or coating thereon comprising a stabilized aerosol forming composition comprising an admixture of a polyhydric alcohol aerosol former, in an effective amount to provide a smokeable aerosol, and a binders wherein the weight ratio of the aerosol former to the binder ranges from about 15:3 to 97:3.

31. The substrate of claim 30, wherein the base material comprises a glass fiber mat.

32. The substrate of claim 30, wherein the coated base material is selected from the group of sheet materials consisting of papers, metal foils, and inert plastic films.

33. The substrate of claim 32, wherein the paper sheet materials are selected from the group consisting of wood pulp based papers, tobacco papers, and mixtures thereof.

34. The substrate of claim 32, wherein the metal foil sheet material is an aluminum foil.

35. The substrate of claim 30, 32, 33, 31, or 34, wherein the binder comprises an alginate binder.

36. The substrate of claim 35, wherein the alginate binder comprises ammonium alginate.

37. The substrate of claim 30, 32, 33, 31, or 34, wherein the binder comprises one or more naturally occurring tobacco binders liberated by a cross-link destabilizing agent.

38. The substrate of claim 37, wherein the binder further comprises an alginate binder.

39. A substrate for smoking articles, comprising a tobacco sheet or web, which is coated with a film composition, in an effective amount to provide a smokeable aerosol, comprising a stabilized admixture of from about 20% to about 85% of a polyhydric alcohol aerosol forming material and from about 1% to about 251 % of a binder.

40. The substrate of claim 39, wherein the polyhydric alcohol aerosol forming material ranges from about 50% to 90%, and the binder ranges from about 2% to about 20%.

41. The substrate of claim 40, wherein the polyhydric alcohol aerosol forming material ranges from about 79% to 85%, and the binder ranges from about 6% to about 15%.

42. The substrate of claim 39, 40, or 41, wherein the binder comprises an alginate binder.

43. The substrate of claim 42, wherein the alginate binder comprises ammonium alginate.

44. The substrate of claim 39, 40, or 41, wherein the binder comprises one or more naturally occurring tobacco binders liberated by a cross-link destabilizing agent.

45. The substrate of claim 44, wherein the binder further comprises an alginate binder.

46. A process for forming a substrate for smoking articles, comprising the steps of:

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(a) spraying tobacco cut filler with a stabilized admixture comprising an aerosol forming polyhydric alcohol and a binder in sufficient water to provide a suitable viscosity for spraying;

(b) drying the sprayed cut filler material to a final moisture content of from about 8% to 12%, at a temperature sufficient to drive off excess water, but low enough so as to prevent significant loss of aerosol forming material.

47. A process for forming a substrate for smoking articles, comprising the steps of:

(a) spraying a polyhydric alcohol aerosol forming substance on tobacco cut filler material;

(b) thereafter spraying an aqueous binder slurry on the treated tobacco; and

(c) drying the twice sprayed cut filler material to a final moisture content of from about 8% to 12%, at a temperature sufficient to drive off excess water, but low enough so as to prevent significant loss of aerosol forming material.

48. A cigarette comprising:

(a) a carbonaceous fuel element less than about 30 mm in length prior to smoking;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising a sheet or web material as a substrate base, said base having a film or coating thereon comprising a stabilized aerosol forming composition comprising an admixture of a polyhydric alcohol aerosol former and a binder, wherein the weight ratio of the aerosol former to the binder ranges from about 15:3 to 97:3; and

(c) a mouthend piece.

49. The cigarette of claim 48, wherein the coated sheet material of the substrate is selected from the group consisting of papers, metal foils, and inert plastic films.

50. The cigarette of claim 48, wherein the paper sheet materials are selected from the group consisting of wood pulp based papers, tobacco papers, and mixtures thereof.

51. The cigarette of claim 48, wherein the metal foil sheet material is an aluminum foil.

52. The cigarette of claim 48, 49, 50, or 51, wherein the binder comprises an alginate binder.

53. The cigarette of claim 52, wherein the alginate binder comprises ammonium alginate.

54. The cigarette of claim 48, 49, 50, or 51, wherein the binder comprises one or more naturally occurring tobacco binders liberated by a cross-link destabilizing agent.

55. The substrate of claim 54, wherein the binder further comprises an alginate binder.

56. A cigarette comprising:

(a) a fuel element;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising a tobacco sheet or web, which is coated with a film composition comprising a stabilized admixture of from about 20% to about 95% of a polyhydric alcohol aerosol forming material and from about 1% to about 25%, of a binder; and

(c) a mouthend piece.

57. The cigarette of claim 56, wherein the polyhydric ohol aerosol forming material ranges from about % to 90%, and the binder ranges from about 2% to about 20%.

58. The cigarette of claim 56, wherein the polyhydric alcohol aerosol forming material ranges from about 79% to 85%, and the binder ranges from about 6% to about 15%.

59. The cigarette of claim 56, 57, or 58, wherein the substrate binder comprises an alginate binder.

60. The cigarette of claim 59, wherein the alginate binder comprises ammonium alginate.

61. The cigarette of claim 56, 57, or 58, wherein the binder comprises one or more naturally occurring tobacco binders liberated by a cross-link destabilizing agent.

62. The substrate of claim 61, wherein the binder further comprises an alginate binder.

63. A cigarette comprising:

(a) a fuel element less than about 30 mm in length prior to smoking;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising a stabilized aerosol forming admixture comprising at least about 15 weight percent of an aerosol forming material and at least about 3 weight percent of a binder; and

(c) a mouthend piece, wherein the substrate binder comprises an alginate binder.

64. The cigarette of claim 63, wherein the substrate composition further comprises up to about 82 weight percent of one or more filler materials, selected from the group consisting of inorganic filler materials, organic filler materials, and mixtures thereof.

65. The cigarette of claim 64, wherein the organic filler material comprises tobacco cut filler.

66. The cigarette of claim 64, wherein the substrate composition further comprises one or more flavor agents.

67. The cigarette of claim 63, wherein the alginate binder comprises ammonium alginate.

68. A cigarette comprising:

(a) a carbonaceous fuel element;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising a rod or roll of shredded strands formed from a cast sheet material formed from an intimate mixture of:

(i) from about 30 to about 55 weight percent of tobacco;

(ii) from about 0 to about 25 weight percent of one or more inorganic or organic filler materials;

(iii) from about 40 to about 50 weight percent of one or more polyhydric alcohol aerosol forming materials; and

(iv) from about 5 to about 8 weight percent of a binder.

69. A cigarette comprising:

(a) a carbonaceous fuel element;

(b) a substrate disposed longitudinally behind said fuel element, said substrate comprising a rod or roll of gathered paper treated with an intimate mixture of:

(i) from about 30 to about 55 weight percent of tobacco;

(ii) from about 40 to about 50 weight percent of one or more polyhydric alcohol aerosol forming materials; and

(iii) from about 5 to about 8 weight percent of a binder.

70. The cigarette of claim 68 or 69, wherein the substrate composition further comprises one or more flavor agents.

71. The cigarette of claim 68 or 69, wherein the substrate binder comprises an alginate binder.

72. The cigarette of claim 71, wherein the alginate binder comprises ammonium alginate.

* * * * *

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UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,396,911
DATED : March 14, 1995
INVENTOR(S) : William J. Casey, III et al.

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Col. 3, line 40, following "12" should be -- %. --.

Col. 17, line 28, "407,S92" should be -- 407,792 --.

Col. 34, line 14, "webs" should be -- web --.

Col. 34, line 19, "binders" should be -- binder, --.

Col. 34, line 47, "251% should be -- 25%.

Signed and Sealed this
Sixth Day of August, 1996

Attest:

BRUCE LEHMAN

Attesting Officer

Commissioner of Patents and Trademarks

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US005568819A

United States Patent [19]

Gentry et al.

[11] Patent Number: 5,568,819

[45] Date of Patent: Oct. 29, 1996

[54] CIGARETTE FILTER

[75] Inventors: Jeffery S. Gentry, Pfafftown; Karen M. Womble, Winston-Salem; Chandra K. Banerjee; Richard L. Blakley, both of Pfafftown; Russell D. Barnes, Belews Creek; Donald A. Calleson, Winston-Salem; Henry T. Ridings, Lewisville, all of N.C.

[73] Assignee: R. J. Reynolds Tobacco Company, Winston-Salem, N.C.

[21] Appl. No.: 264,217

[22] Filed: Jun. 22, 1994

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 76,711, Jun. 11, 1993, Pat. No. 5,404,890.

[51] Int. Cl.[6] A24D 3/00; A24D 1/02

[52] U.S. Cl. 131/342; 131/361; 131/365; 131/344; 131/331; 131/339

[58] Field of Search 131/342, 361, 131/365, 344, 331, 339

[56] References Cited

U.S. PATENT DOCUMENTS

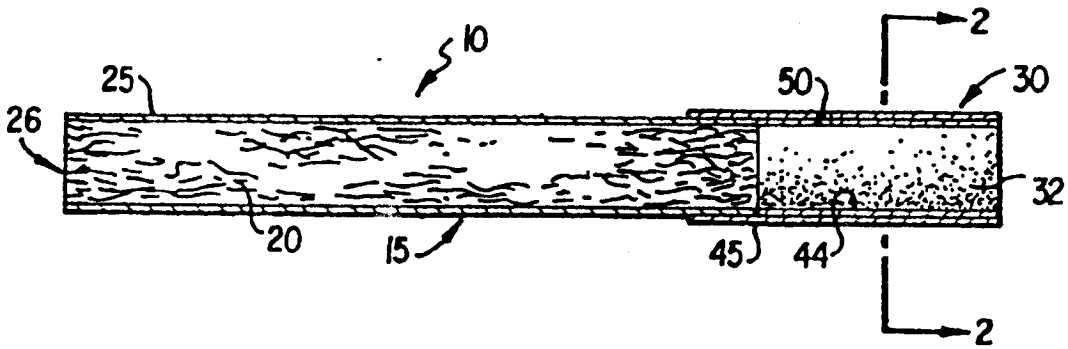
3,894,545	7/1975	Crellin et al.	131/339
4,807,809	2/1989	Pryor et al.	131/342
5,404,890	4/1995	Gentry et al.	131/342

Primary Examiner—Nathan M. Nutter
Assistant Examiner—Duc Truong

[57] ABSTRACT

A cigarette includes a filter element including a carbon-containing paper or a paper containing molecular sieves. The paper contacts the filter material, such as cellulose acetate tow, within the filter element, either by circumscribing the filter material or by being gathered with non-carbon-containing filter material. The paper is useful as a plug wrap for a filter element. In several embodiments, longitudinal grooves are provided on the periphery of the filter element.

19 Claims, 3 Drawing Sheets



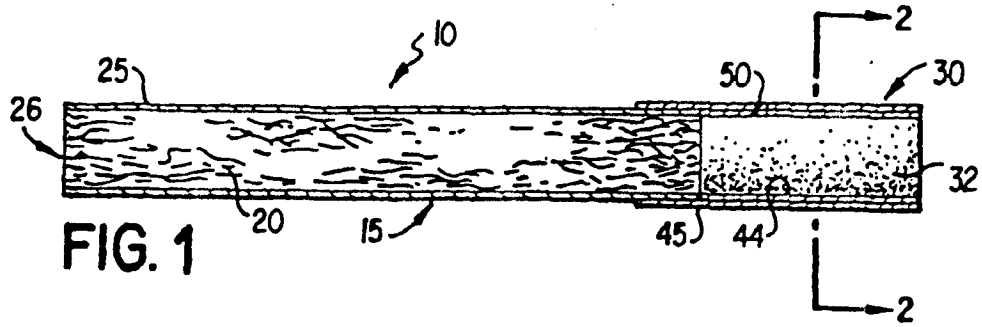


FIG. 1

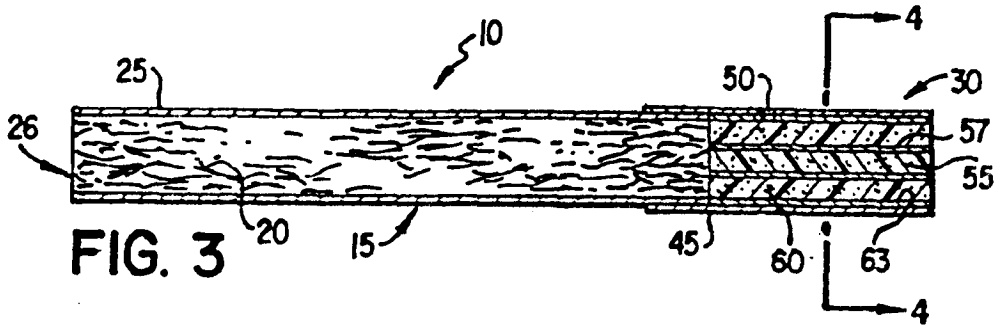


FIG. 3

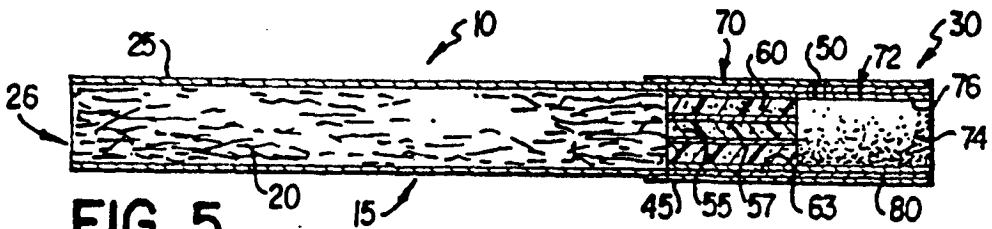


FIG. 5

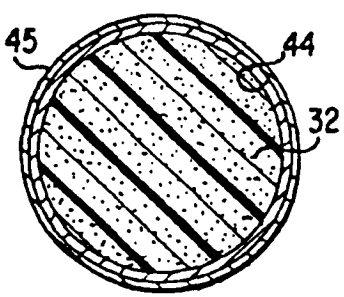


FIG. 2

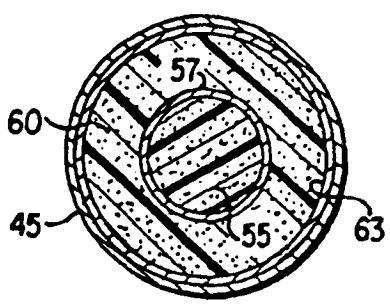


FIG. 4

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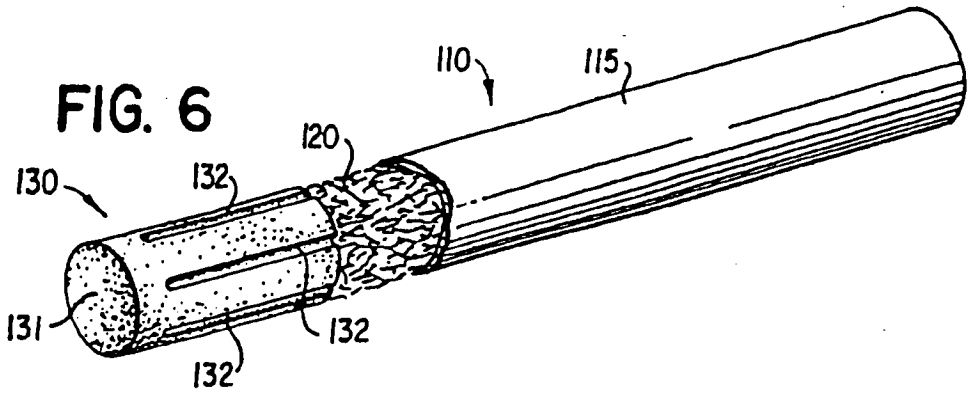
FIG. 6



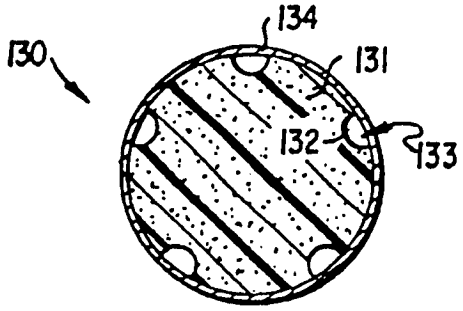


FIG. 7

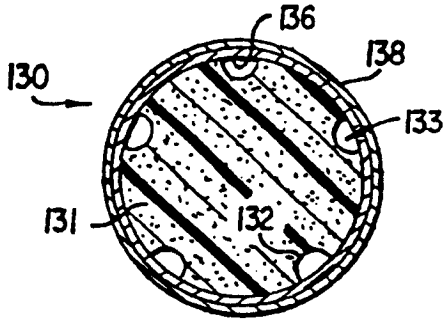


FIG. 8

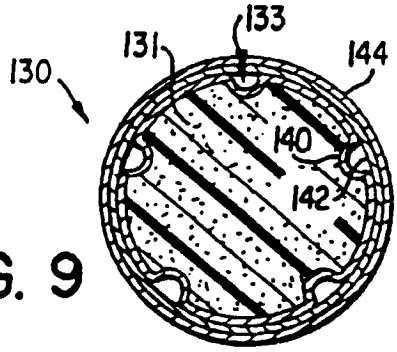


FIG. 9

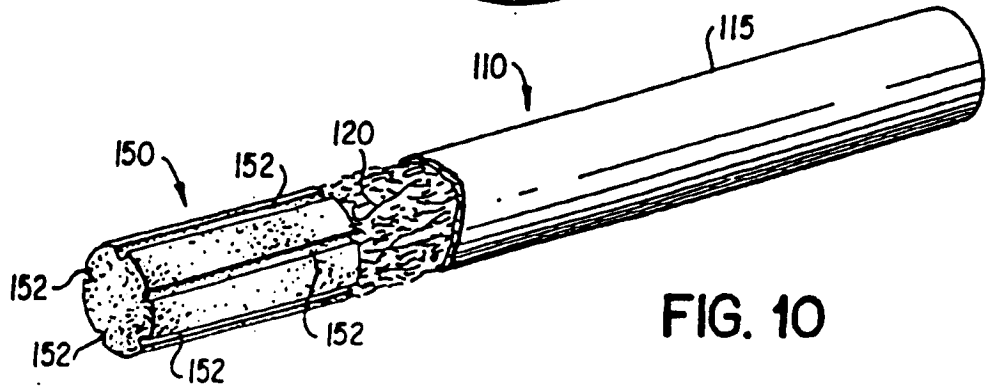


FIG. 10

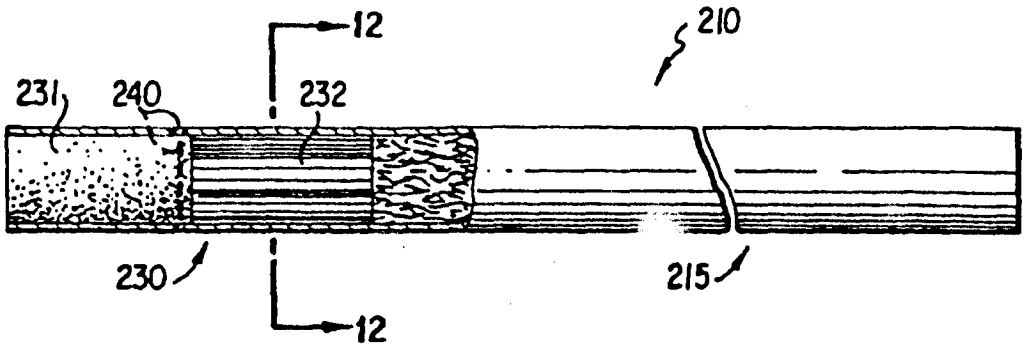


FIG. 11

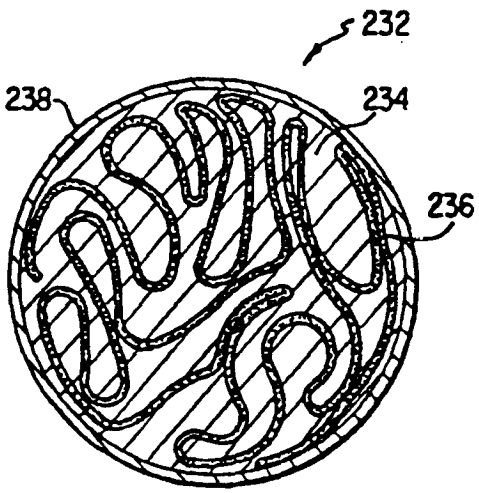


FIG. 12

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CIGARETTE FILTER

CONTINUING APPLICATION INFORMATION

This application is a continuation-in-part of U.S. patent application Ser. No. 08/076,711 filed Jun. 11, 1993, now U.S. Pat. No. 5,404,890.

BACKGROUND OF THE INVENTION

The present invention relates to smoking articles such as cigarettes, and in particular, to cigarettes having filter elements containing a carbonaceous material.

Popular smoking articles, such as cigarettes, have a substantially cylindrical rod shaped structure and include a charge of smokable material such as shredded tobacco (e.g., in cut filler form) surrounded by a paper wrapper thereby forming a so-called "tobacco rod." Normally, a cigarette has a cylindrical filter element aligned in an end-to-end relationship with the tobacco rod. Typically, a filter element includes cellulose acetate tow circumscribed by plug wrap, and is attached to the tobacco rod using a circumscribing tipping material. It also has become desirable to perforate the tipping material and plug wrap, in order to provide dilution of drawn mainstream smoke with ambient air.

Cigarettes are employed by the smoker by lighting one end thereof and burning the tobacco rod. The smoker then receives mainstream smoke into his/her mouth by drawing on the opposite end (e.g., the filter end) of the cigarette.

Certain cigarettes have filter elements which incorporate materials such as carbon. Exemplary cigarettes and filters therefore are described in U.S. Pat. Nos. 2,881,770 to Tovey; 3,353,543 to Sproull et al.; 3,101,723 to Seligman et al.; and 4,481,958 to Ranier et al. and European Patent Application No. 532,329. Certain commercially available filters have particles or granules of carbon (e.g., an activated carbon material or an activated charcoal material) dispersed within cellulose acetate tow; other commercially available filters have carbon threads dispersed therein; while still other commercially available filters have so-called "cavity filter" or "triple filter" designs. Exemplary commercially available filters are available as SCS IV Dual Solid Charcoal Filter from American Filtrona Corp.; Triple Solid Charcoal Filter from FIL International, Ltd.; Triple Cavity Filter from Baumgartner; and ACT from FIL International, Ltd. See, also, Clarke et al., *World Tobacco*, p. 55 (Nov., 1992).

Cigarette filter elements which incorporate carbon have the ability to change the character of mainstream smoke which passes therethrough. For example, such filter elements have the propensity to reduce the levels of certain gas phase components present in the mainstream smoke, resulting in a change in the organoleptic properties of that smoke.

However, such filter elements often incorporate relatively high levels of carbon (e.g., in particulate form), and/or are longitudinally segmented in format and configuration. As such, filter elements incorporating carbon require numerous and labor intensive processing steps; and cigarettes incorporating such filter elements often can be characterized as having slightly metallic drying and powdery flavor characteristics.

It would be desirable to provide a cigarette having a cigarette element incorporating carbon or other material capable of absorbing and/or adsorbing gas phase components present in mainstream cigarette smoke, which filter element can be manufactured in an efficient and effective manner.

SUMMARY OF THE INVENTION

The present invention relates to cigarettes having a charge or roll of smokable material contained in a circumscribing wrapping material to form a so-called "smokable rod" or "tobacco rod". The smokable material is a smokable filler material comprising tobacco cut filler material. Normally, the smokable material is all tobacco cut filler material, and preferably that cut filler material has been cased and/or top dressed. The wrapping material is a paper wrapping material.

Cigarettes of the present invention each include a filter element which acts as a mouthpiece. The filter element includes a filter material (e.g., cellulose acetate tow), and a carbonaceous material or other material capable of absorbing and/or adsorbing gas phase components present in mainstream cigarette smoke.

In a first preferred embodiment, the filter element includes one longitudinally extending segment, as opposed to a filter element having two or more longitudinally positioned filter segments. However, in a second embodiment, the filter element can be concentric in nature, and as such, have a plurality of segments each of which extend along the total length of that filter element. The carbonaceous material (e.g., an activated carbon material or an activated charcoal material in a powdered or fine grain form) is incorporated into the filter element as a component of a paper (e.g., the paper includes a carbonaceous material as a component thereof). Alternatively, the carbonaceous material within the paper can be replaced by another material capable of absorbing and/or adsorbing gas phase components from smoke passing through the filter element. Such other material can be in the form of alumina granules, microsponge particles, molecular sieve particles (e.g., zeolite granules), and the like. Typically, the paper which incorporates the carbonaceous material is incorporated into the filter element in a configuration resembling a tube which extends from one end of the filter element to the other. For example, the paper incorporating the carbonaceous material can (i) act as a plug wrap material for a filter material, and/or (ii) act as a circumscribing wrap for an inner or core of filter material which is in turn circumscribed by an outer or sheath of filter material.

In a third embodiment, the filter element includes two or more longitudinally positioned segments. As such, the segments can be combined in a variety of arrangements, depending upon the properties of the components of the individual segments and the desired characteristics of the filter element. At least one segment of such a filter element includes the paper incorporating the carbonaceous material, which paper (i) acts as a plug wrap material for the filter material of that segment, and/or (ii) acts as a circumscribing wrap for an inner region or core of filter material which is in turn circumscribed by an outer or sheath of filter material.

The tobacco rod and filter element are secured together using a tipping material. The resulting cigarette optionally can be air diluted (e.g., by perforating the tipping material in the regions which overlies the filter elements or by other such air dilution means). When air diluted, the filter element normally is ventilated to provide a cigarette having an air dilution between about 25 and about 75 percent. As used herein, the term "air dilution" is the ratio (expressed as a percentage) of the volume of air drawn through the air dilution means to the total volume of air and smoke drawn through the cigarette and exiting the extreme mouthend portion of the cigarette. See, Selke, et al., *Beitr. Zur Tabak. In.*, Vol. 4, p. 193 (1978).

In a fourth embodiment, a filter element preferably of highly impervious cellulose acetate tow is provided having a plurality of longitudinally extending grooves on the outer periphery of the filter element. The grooves extend substantially along the length of the filter element, but terminate before the mouthpiece end of the filter element. In fourth, fifth and sixth embodiments, one or more layers of a carbonaceous material, such as a carbon-containing paper, are wrapped about the filter element. The grooves and the carbon-containing paper form a channel through which mainstream smoke is drawn and with which the smoke interacts, thereby absorbing and/or adsorbing gas phase components of the smoke, before the smoke passes back through the region of the filter element near the mouthpiece end. In a seventh embodiment, the grooves extend along the entire length of the filter. Instead of using grooves to form channels for the smoke, an embossed pattern can be provided on the outer surface of the filter element, which is overwrapped by carbon-containing paper. As in the previously described embodiments, the filter element and tobacco rod are secured together using a tipping material. Air ventilation can be provided by making a hole in each channel.

In an eighth embodiment, a web of filter material such as cellulose acetate tow or other suitable material free of carbon particles is gathered simultaneously with a carbon-containing paper to form a filter segment having essentially randomly arranged flow channels formed by the carbon-containing paper and filled with a porous web through which cigarette smoke passes, with the smoke interacting with the carbon-containing paper, so as to absorb and/or adsorb gas phase components of the smoke. As in the previous embodiments, the filter segment is overwrapped by a layer of plug wrap. A mouthpiece end is provided of cellulose acetate tow or other suitable filter material and having ventilation holes formed therein near the junction with the carbon-containing segment. The entire filter is joined to a rod of smokable material by tipping material.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a cigarette of a first embodiment of the present invention;

FIG. 2 is a radial sectional view of the cigarette of FIG. 1 taken along line 2—2;

FIG. 3 is a longitudinal sectional view of a cigarette of a second embodiment of the present invention;

FIG. 4 is a radial sectional view of the cigarette of FIG. 3 taken along line 4—4;

FIG. 5 is a longitudinal sectional view of a cigarette of a third embodiment of the present invention;

FIG. 6 is a perspective view in partial fragmented section of a cigarette of a fourth embodiment of the present invention;

FIG. 7 is a radial cross-sectional view of a cigarette filter of the fourth embodiment of the invention;

FIG. 8 is a radial cross-sectional view of a cigarette filter of a fifth embodiment of the invention;

FIG. 9 is a radial cross-sectional view of a cigarette filter of a sixth embodiment of the invention;

FIG. 10 is a perspective view in partial fragmented section of a cigarette of a seventh embodiment of the invention;

FIG. 11 is a partial fragmented sectional view of a cigarette of an eighth embodiment of the invention; and

FIG. 12 is a sectional view of a cigarette filter of the eighth embodiment, taken along line 12—12. of FIG. 11.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment of a cigarette of the present invention is shown in FIG. 1. Cigarette 10 includes a generally cylindrical rod 15 of smokable material 20, such as tobacco cut filler, contained in a circumscribing wrapping material 25. The rod 15 hereinafter referred to as a "tobacco rod." The ends of the tobacco rod 15 are open to expose the smokable material. The tobacco rod is used by lighting one end thereof, and aerosol (e.g., smoke) is provided as a result of the combustion of the burning smokable material 20, which is lit at lighting end 26. As such, the tobacco rod burns back from the lit end thereof towards the opposite end (i.e., mouthend) thereof, and the smokable material of the tobacco rod is consumed by combustion during the smoking period.

The cigarette 10 also includes a filter element 30 positioned adjacent one end of the tobacco rod 15 such that the filter element and tobacco rod are axially aligned in an end-to-end relationship, preferably abutting one another. Filter element 30 has a generally cylindrical shape, and the diameter thereof is essentially equal to the diameter of the tobacco rod. The ends of the filter element are open to permit the passage of air and smoke therethrough.

Filter element 30 includes a filter material 32 (e.g., starch-based, polypropylene, or plasticized cellulose acetate tow) circumscribed by plug wrap 44. The filter material also can have the form of a gathered web (e.g., polypropylene web, polyester web or starch-based web), which is gathered using techniques such as are described in U.S. Pat. No. 4,870,809 to Pryor et al. If desired, the filter material can have at least one tubular capillary, passage or groove (not shown) extending longitudinally therethrough or partially therethrough. The plug wrap 44 is a paper which incorporates a carbonaceous material. The plug wrap circumscribes the total length of the filter element.

The filter element 30 is attached to the tobacco rod 15 by tipping material 45 which circumscribes both the entire length of the filter element and an adjacent region of the tobacco rod. The inner surface of the tipping material 45 is fixedly secured to the outer surface of the plug wrap 44 and the outer surface of the wrapping material 25 of the tobacco rod, using a suitable adhesive. A ventilated or air diluted smoking article is provided with an air dilution means, such as a series of perforations 50, each of which extend through the tipping material and plug wrap.

Referring to FIG. 3, a second embodiment of a cigarette 10 of the present invention is shown. The cigarette shown in FIG. 3 is generally similar to that cigarette described with reference to FIG. 1. However, the filter element 30 includes an inner core of filter material 55 (e.g., gathered paper, gathered polyolefin web, gathered polyester web or cellulose acetate tow) circumscribed by paper wrap 57. As such, the filter element is concentric in configuration. The paper wrap 57 is a paper which most preferably incorporates a carbonaceous material. The paper wrap 57 has the form of a tube which extends from one end of the filter element to the other. The paper wrap 57 is circumscribed by filter material 60, which is in turn circumscribed by plug wrap 63. The plug wrap 63 can be a conventional paper plug wrap material or a paper which incorporates a carbonaceous material. The filter material 60 which forms a sheath can be a gathered paper, cellulose acetate tow, gathered polyolefin (e.g., polyethylene or polypropylene) web or a gathered polyester web. Preferably, the core filter material is different in character or composition from the outer sheath material. The filter material also can be provided from a plasticized, non-wrapped

cellulose acetate filter rod, such as is available from American Filtrona Corp. One example of a suitable filter element is one having a core region of a cellulose acetate tow item of 1.6 denier per filament/48000 total denier and a sheath region of a cellulose acetate tow item of 8.0 denier per filament/40000 total denier, wherein either or both of the filter materials can be circumscribed by a carbon-containing paper.

Referring to FIG. 2, a cross-sectional view of the filter element described with reference to FIG. 1 is shown. As such, the plug wrap 44 appears as a black ring around the filter material 32.

Referring to FIG. 4, a cross-sectional view of the filter element described with reference to FIG. 3 is shown. As such, the plug wrap 63 which incorporates a carbonaceous material appears as a black ring around filter material 60, and paper wrap B7 appears as a black ring between filter materials 55 and 60.

Referring to FIG. 5, another embodiment of a cigarette 10 of the present invention is shown. The cigarette shown in FIG. 5 is generally similar to that cigarette described with reference to FIG. 3. However, the filter element 30 includes two longitudinally positioned segments, a first segment 70 which is generally similar to that filter element described with reference to FIG. 3 (i.e., there are at least two tubes of paper containing carbonaceous material positioned within that segment), and a second segment 72 which includes a filter material 74 and a circumscribing plug wrap 76. The plug wrap 76 can be a conventional paper plug wrap material or a paper which incorporates a carbonaceous material. Alternatively, the first segment 70 can be generally similar to the filter element described with reference to FIG. 1. If desired, the first filter segment can have at least one tubular capillary or passage (not shown) extending longitudinally therethrough. Typically, such a passageway which extends through the first filter segment is provided from a narrow tube of cellulose acetate, polyethylene, polypropylene, or other plastic material. Typically, such a tube has an inner diameter of about 0.01 to about 0.06 inch, and usually about 0.03 to about 0.04 inch. If desired, the filter material of the first segment can contain flavoring agents and certain other additives, such as is described in U.S. patent application Ser. No. 945,042, filed Sep. 15, 1992. Typically, the first and second filter segments are different in length and/or composition of components. The two filter segments are longitudinally disposed relative to one another such that the first segment 70 is positioned adjacent one end of the tobacco rod, and the second segment 72 is positioned adjacent one end of the first segment and at the extreme mouthend of the cigarette. The two segments are maintained in an abutting end-to-end relationship by a circumscribing outer plug wrap material 80. Such filter elements can be provided using known techniques (e.g., using a Mulfi or plug tube combination machinery).

The smokable material employed in the manufacture of the tobacco rod can vary. For example, the smokable material of the cigarette can have the form of filler (e.g., tobacco cut filler). As used herein, the terms "filler" or "cut filler" are meant to include tobacco materials and other smokable materials which have a form suitable for use in the manufacture of tobacco rods for cigarettes. As such, filler can include smokable materials which are blended and are in a form ready for cigarette manufacture. The filler materials normally are employed in the form of strands or shreds as is common in conventional cigarette manufacture. For example, the cut filler material can be employed in the form of strands or shreds from sheet-like or "strip" materials which are cut into widths ranging from about 1/30 inch to about 1/60 inch, preferably from about 1/25 inch to about 1/35 inch. Generally, such strands or shreds have lengths which range from about 0.25 inch to about 3 inches.

Examples of suitable types of tobacco materials include flue-cured, Burley, Maryland or Oriental tobaccos, the rare or specialty tobaccos, and blends thereof. The tobacco material can be provided in the form of tobacco lamina; processed tobacco materials such as volume expanded or puffed tobacco, processed tobacco stems such as cut-rolled or cut puffed stems, reconstituted tobacco materials; or blends thereof. Certain reconstituted tobacco materials are described in U.S. Pat. Nos. 4,962,774 to Thomasson et al.; 4,987,906 to Young, et al.; 5,159,942 to Brinkley et al.; 5,099,864 to Young et al.; 5,143,097 to Sohn et al.; and 5,056,537 to Brown et al.; and in European Patent Application Nos. 419,733 and 535,834. Certain processed tobacco materials are described in U.S. Pat. Nos. 5,025,812 to Fagg, et al. and 5,065,775 to Fagg. Certain blends are described in U.S. Pat. Nos. 4,924,888 to Perfetti, et al.; 4,942,888 to Montoya, et al.; and 4,998,541 to Perfetti, et al. Preferably, the smokable material or blend of smokable materials consists essentially of tobacco filler material or consists only of tobacco filler material. Also of particular interest are smokable materials or blends of smokable materials, that when incorporated into tobacco rods which would provide mainstream smoke which would be perceived by the smoker to be harsh, woody, papery, bitter, sour, hot and irritating when smoked in cigarettes incorporating filter elements which are not filter elements of the present invention. For example, smokable filler consisting essentially of reconstituted tobacco material, consisting only of reconstituted tobacco material, incorporating relatively high levels of tobacco stems, or incorporating high levels of reconstituted and volume expanded tobacco materials can be employed in cigarettes employing the filter elements of the present invention. Exemplary cigarettes also are described in U.S. patent application Ser. No. 08/075,696, filed Jun. 11, 1993.

Smokable materials can be cased and top dressed as is conventionally performed during various stages of cigarette manufacture. As such, the smokable material, and particularly tobacco filler material, can include casing and/or top dressing components. For example, blend components such as flavoring agents and humectants, as well as other forms of tobacco (e.g., tobacco extracts), can be applied to the smokable material, as is commonly performed when cigarettes are manufactured. See, Leffingwell, et al., *Tobacco Flavoring For Smoking Products* (1972). Suitable flavoring agents and forms of tobacco include vanillin, tobacco extracts such as tobacco essences and tobacco aroma oils, cocoa, licorice, menthol, and the like. Flavor modifying agents such as levulinic can be applied to the smokable material (e.g., in amounts ranging from about 0.01 to about 2 percent, normally from about 0.1 to about 1 percent, preferably about 0.2 to about 0.6 percent, based on the dry weight of the smokable material). Such components conveniently are applied to the smokable material as casing and top dressing components. See, U.S. Pat. No. 4,830,028 to Lawson, et al.

Typically, the tobacco rod has a length which ranges from about 35 mm to about 85 mm, preferably about 40 to about 70 mm; and a circumference of about 17 mm to about 27 mm, preferably about 22.5 mm to about 25 mm. Short cigarette rods (i.e., having lengths from about 35 mm to about 50 mm) can be employed, particularly when smokable blends having a relatively high packing density are employed.

The packing densities of the blend of smokable materials contained within the wrapping materials can vary. Typical packing densities for tobacco rods of cigarettes of the present invention range from about 150 to about 300 mg/cm^3 . Normally, packing densities of the tobacco rods range from about 200 to about 280 mg/cm^3.

Exemplary tobacco rods having two layers of wrapping material circumscribing a charge of tobacco cut filler are described in U.S. Pat. No. 5,159,944 to Arzonico et al., in Examples 1 through 32 of U.S. patent application Ser. No. 07/661,747, filed Feb. 27, 1991, and in Examples 1 through 25 of U.S. patent application Ser. No. 07/759,266, filed Sep. 13, 1991, which are incorporated herein by reference.

Typically, the filter element has a length which ranges from about 15 mm to about 40 mm, preferably about 20 mm to about 35; and a circumference of about 17 mm to about 27 mm, preferably about 22 mm to about 25 mm. The filter element can have a wide range of filtration efficiencies.

The manner in which filter elements of the present invention are manufactured can vary. Filter tow (e.g., cellulose acetate or polypropylene tow) can be processed using a tow processing unit (e.g., an E-60 unit available from Arjay Equipment Corp., Inc.) and formed into a filter rod using a rod making unit (e.g., a KDF-2 rod making apparatus from Hauni-Werke Korber & Co., K.G.), wherein the paper plug wrap is provided using a paper plug wrap containing a carbonaceous material. A concentric filter can include an inner core of gathered paper or cellulose acetate tow circumscribed by a paper containing a carbonaceous material, which is in turn circumscribed by a sheath of cellulose acetate tow, which is in-turn circumscribed by a paper plug wrap. If desired the concentric filter can be provided from a filter material circumscribed by paper containing a carbonaceous material which is then inserted to fit snugly into the central passageway of a non-wrapped acetate plasticized cellulose acetate tube.

The filter elements can be manufactured using a rod making unit available as CU-10, CU-20 or CU-20S from Decoufle s.a.r.b. together with a KDF-2 rod making unit. As such, the carbon-containing paper which is used to provide the plug wrap of the filter can be embossed or patterned, typically so as to include a plurality of longitudinally extending serrations or corrugations. As such, there can be provided numerous air flow passageways between the tipping paper and the plug wrap. Typically, corrugations can be in the form of ridges spaced about 1 mm to about 2 mm, and often about 1.5 mm to about 1.7 mm apart and about 0.1 to about 1 mm, often about 0.7 mm to about 0.9 mm deep. When such a corrugated plug wrap is employed, the cigarette can be air diluted by perforating the tipping paper, but not perforating the plug wrap in order that the air which dilutes the smoke during draw experiences a tendency to pass through the air flow passageways between the tipping paper and plug wrap and into the mouth of the smoker. Representative concentric filters which can be modified so as to have the carbon-containing paper incorporated therein are described in European Patent Application No. 474,940.

The amount of carbonaceous material incorporated within a carbon-containing paper can vary. Typically, the amount of carbonaceous material within such paper is more than about 10, usually more than about 20, generally more than about 25, often more than about 30, and frequently, more than about 40 weight percent, based on the dry weight of the paper. Typically, the amount of carbonaceous material within such paper is less than about 65, often less than about 60 and frequently less than about 55 weight percent, based on the dry weight of the paper. Similar amounts of the other materials capable of absorbing and/or adsorbing gas phase components from cigarette smoke also can be incorporated into the paper in place of the carbonaceous material.

The amount of carbonaceous material within the filter segment containing the gathered paper containing that material typically ranges from about 20 to about 120 mg, often about 40 to about 110 mg, and frequently about 60 to about 100 mg. Similar amounts of the other materials capable of absorbing and/or adsorbing gas phase components from cigarette smoke also can be incorporated into the paper in place of the carbonaceous material.

Typically, the weight of the carbon-containing paper or similar paper within the filter segment incorporating that paper ranges from about 75 to about 250 mg, generally about 100 to about 225 mg and often about 125 to about 200 mg.

The carbonaceous material which is incorporated into the filter element can vary. Most preferred carbonaceous materials are highly activated. The degree of activation can vary, and typically is such so as to provide about 25 to about 125, more typically about 60 to about 70, weight percent pickup of carbon tetrachloride. Carbonaceous materials most useful herein have a high carbon content; consist primarily of carbon; and preferably have a carbon content above about 80 weight percent, and more preferably above about 90 weight percent. Preferred carbonaceous materials are provided by carbonizing or pyrolyzing bituminous coal, tobacco material, softwood pulp, hardwood pulp, coconut hulls, kapok fibers, cotton fibers, cotton liners, and the like. Examples of suitable carbonaceous materials are activated coconut hull based carbons available from Calgon Corp. as PCB, PCGB and GRC-11. Examples of suitable carbonaceous materials are coal based carbons available from Calgon Corp. as S-Sorb, BPL, CRC-11F, FCA and SGL. Examples of suitable carbonaceous materials are wood based carbons available from Westvaco as WV-B, SA-20 and BSA20. Other carbonaceous materials are available from Calgon Corp. as HMC, ASC/GR-1 and SC II. Another carbonaceous material includes Witco Carbon No. 637. Other carbonaceous materials are described in U.S. patent application Ser. No. 07/569,325, filed Aug. 17, 1990; U.S. Pat. Nos. 4,771,795 to White, et al. and 5,027,837 to Clearman, et al.; and European Patent Application Nos. 236,922; 419,733 and 419,981. Certain carbonaceous materials, which can be activated, can be impregnated with substances such as silver, copper, platinum, palladium, potassium bicarbonate, tobacco extracts, menthol, polyethyleneimine, manganese dioxide, chromate salts, eugenol, and 4-ketononanoic acid.

The size of the individual carbonaceous powder, particles or granules can vary, depending upon the desired design of the filter element. The individual powdered or fine grain carbonaceous particles typically have a diameter of about 10 μm to about 250 μm, often about 20 μm to about 100 μm, and frequently 30 μm to about 70 μm. Particularly preferred powdered or fine grain particles can be characterized as having an average diameter of about 40 μm, or such that 90 percent of the particles or fine grains pass through a 325 U.S. mesh screen. The materials which are incorporated into the paper in place of the carbonaceous material can have similar particle sizes.

The carbon-containing paper includes other materials. The paper includes at least one cellulosic material, can include at least one inorganic filler, and can include other additives or ingredients employed in the paper making industry. Exemplary cellulosic materials include flax fibers, hardwood pulp (preferably unbleached), softwood pulp

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(preferably unbleached), cotton fibers, tobacco parts (e.g., tobacco laminae and stem pieces), and the like. Exemplary inorganic filler materials include agglomerated calcium carbonate particles, calcium carbonate particles, calcium sulfate fibers, precipitated magnesium hydroxide gel, clay particles, and the like. Most preferably, the materials which make up the paper are incorporated into the paper during manufacture using the paper making process. Components such as sizing agents and moisture also can be incorporated into the carbon-containing paper. Typically, the amount of sizing agent incorporated into the paper is less than about 5 weight percent, and often about 0.1 to about 3 weight percent; and the moisture content of the paper ranges from about 5 to about 15 weight percent, and often about 8 to about 12 weight percent. Flavoring agents and other smoke modifying agents (e.g., tobacco extracts, heat treated tobacco extracts, spearmint, vanillin, anethole and menthol) also can be incorporated into the carbon-containing paper. Exemplary tobacco extracts are spray dried extracts and are described in U.S. Pat. No. 5,060,669 to White et al. A preferred carbon-containing paper consists essentially of softwood pulp and carbonaceous material. Certain carbon-containing papers are absent of tobacco material. Certain carbon-containing papers are absent of inorganic fillers (e.g., calcium carbonate particles), and are absent of thermoplastic fibers (e.g., polyethylene, polypropylene or polyester fibers).

The physical properties of the carbon containing paper or similar types of papers can vary. The thickness of the paper typically ranges from about 0.08 mm to about 0.2 mm, often about 0.13 mm to about 0.18 mm. The basis weight of the paper typically ranges from about 25 g/m^2 to about 60 g/m^2, often about 45 g/m^2 to about 55 g/m^2. The tensile strength of the paper preferably is at least about 800 g/in, typically ranges from about 1100 g/in to about 2300 g/in, although papers having greater tensile strengths can be employed. The porosity (i.e., inherent porosity) of the paper preferably is quite high, but typically ranges from about 50 to about 300 CORESTA units, often about 70 to about 200 CORESTA units. The paper can be electrostatically perforated to provide a relatively high net permeability. Typically, papers having exceedingly low porosities have a tendency to provide relatively low removal efficiencies of gas phase components of mainstream smoke.

Exemplary carbon-containing papers are available as P-144-17AC, P-144-30AC, P-144-50AC, P-144-50 HMC, P-144-50 SGL, P-144-BSHE, P-144-BAC, P-144-50-SA20, P-144-70-KCG, P-144-70SA20, P-2674-12-12, P-2674-13-17, P-2674-14-24, P-2674-11-3, P-2674-11-7, P-3122-6-8, P-3122-6-6, P-3122-6-5, P-3122-6-121, P-3001-72-1, P-144-BHC XCCW/KCB65, XCCW/KCG50, XCCW/KCG30, XCCW/KCG17, GPRCW/50KG, GPRCW/50SPEC, from Kimberly-Clark Corp. Other carbon-containing papers are described in European Patent Application Nos. 342,538 and 532,329, which is incorporated herein by reference. Other carbon-containing papers will be apparent to the skilled artisan. For example, carbon particles can be embedded in a paper substrate and employed as a wrapping material for a filter segment. If desired, papers containing granular molecular sieves rather than carbon particles can be employed. A representative paper is available from Kimberly-Clark Corp. and is designated as ABS-50. Such a paper includes about 50 weight parts softwood pulp and about 50 weight parts molecular sieve particles available as Abscent Molecular Sieve from Union Carbide Corp. If desired, conjugated polyunsaturated isoprenoids (e.g., betacarotene) can be incorporated into the paper (e.g., by spraying, printing, or the like). See, U.S. patent application Ser. No. 08/075,696, filed Jun. 11, 1993.

If desired, the filter materials which are used can have flavoring agents (e.g., menthol) incorporated therein.

Typically, the tipping material circumscribes the filter element and an adjacent region of the tobacco rod such that the tipping material extends about 3 mm to about 6 mm along the length of the tobacco rod. Typically, the tipping material is a conventional paper tipping material and is adhesively secured to the filter element and the adjacent region of the tobacco rod. The tipping material can have a permeability which can vary. For example, the tipping material can be essentially air impermeable, air permeable, or be treated (e.g., by mechanical or laser perforation techniques) so as to have a region of perforations, openings or vents thereby providing a means for providing air dilution to the cigarette. The total surface area of the perforations and the positioning of the perforations along the periphery of the cigarette can be varied in order to control the performance characteristics of the cigarette.

For air diluted or ventilated cigarettes of this invention, the amount of air dilution can vary. Often, the amount of air dilution for an air diluted cigarette is greater than about 10 percent, and frequently greater than about 25 percent. The upper limit of air dilution for a cigarette typically is less than about 75 percent, more frequently less than about 65 percent.

Cigarettes of the present invention exhibit a desirably high resistance to draw. For example, cigarettes of this invention exhibit a pressure drop of between about 50 and about 200 mm water pressure drop at 17.5 cc/sec. air flow. Typically, pressure drop values of cigarettes are measured using a Filtrona Filter Test Station (CTS Series) available from Filtrona Instruments and Automation Ltd. Cigarettes of this invention preferably exhibit resistance to draw values of about 70 to about 180, more preferably about 80 to about 50 mm water pressure drop at 17.5 cc/sec. air flow.

Cigarettes of the present invention generally provide FTC "tar" yields in the range from about 2 to about mg/cigarette, although other "tar" yields are possible. Typical FTC "tar" to FTC carbon monoxide ratios for such cigarettes are less than about 1.5, and sometimes are less than about 1.2. If desired, suitable catalytic compounds for the removal of carbon monoxide can be incorporated into the filter element. Cigarettes of the present invention exhibit desirable organoleptic properties. Cigarettes having carbonaceous materials within the filter element preferably exhibit a smooth smoking character, and provide less harsh and less bitter attributes than comparable cigarettes not having such a filter element. Preferred filter elements assist in reducing the gas phase components of cigarette smoke that have a propensity to provide a harsh, irritating, stingy, sour and bitter character to mainstream tobacco smoke. As such, cigarettes of the present invention are capable of providing the smoker with mainstream smoke which is smooth tasting, exhibits good strength and body, exhibits good tobacco smoke flavor, and yields an acceptable aftertaste. The filter elements of the present invention are capable of removing condensable gas phase components from mainstream tobacco smoke to a significant degree. Condensable gas phase components include organic compounds such as hydrogen cyanide, isoprene, 1,3-butadiene, and carbonyl compounds (e.g., acetone, formaldehyde, acrolein and acetaldehyde). Cigarettes of the present invention typically exhibit yields of certain mainstream condensable gas phase components which are less than 80 percent, and frequently are less than 75 percent, that of those yields of a cigarette of similar format and configuration but employing a filter segment not incorporating the carbonaceous material used according to the present invention.

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Although not preferred, it is possible to incorporate filter elements of the present invention into those types of cigarettes described in U.S. Pat. Nos. 5,178,167 to Riggs et al.; 5,183,062 to Clearman et al.; 5,203,355 to Clearman et al.; 5,156,170 to Clearman et al.; 5,137,034 to Perfetti et al.; 5,076,292 to Sensabaugh, Jr., et al.; 5,065,776 to Lawson et al.; 5,067,499 to Banerjee et al.; 5,060,666 to Clearman et al.; 5,033,483 to Clearman et al.; 4,989,619 to Clearman et al.; 5,020,548 to Farrier et al.; 5,105,837 to Barnes; 4,714,082 to Banerjee et al.; 4,854,311 to Banerjee et al.; and 4,881,556 to Clearman et al.; and U.S. patent application Ser. Nos. 08/040,227; 07/856,239; 07/882,209; 07/947,002; 07/800,679; 08/018,637; 08/049,056; 08/043,886; and 07/947,021.

The following examples are provided in order to further illustrate the invention but should not be construed as limiting the scope thereof. Unless otherwise noted, all parts and percentages are by weight.

EXAMPLE 1

Cigarettes substantially as shown in FIG. 1 are provided as follows:

The cigarettes each have a length of about 83 mm and a circumference of about 24.4 mm. The tobacco rod has a length of about 56 mm, and the filter element has a length of about 27 mm. Each filter element includes a cellulose acetate tow (2.7 denier per filament/39000 total denier) plasticized using triacetin and circumscribed by a 0.98 inch width of carbon-containing paper available as XCCW/KCG-50 or P-144-KGG-50 from Kimberly-Clark Corp. Such a paper is made of about 50 parts carbon, abut 50 parts wood pulp. The filter element is made by wrapping the paper wrap around the length of the cylindrical segment of filter material.

The smokable material is an American blend of fluecured, Burley, Oriental, reconstituted and volume expanded tobaccos in cut filler form. The blend has been cased and top dressed. The paper wrapper of the tobacco rod is available as Ref. No. 456 from Miguel y Costas.

The filter element is attached to the tobacco rod using paper tipping material. The cigarette is not air diluted.

EXAMPLE 2

Cigarettes are provided essentially as described in Example 1; however, the cigarette is air diluted to a level of 25 percent air dilution by providing a ring of perforations in the filter element about 13 mm from the extreme mouthend of the cigarette.

EXAMPLE 3

Cigarettes are provided essentially as described in Example 2; however, the cigarettes are air diluted to a level of 50 percent air dilution.

EXAMPLE 4

Cigarettes are provided, essentially as described in Example 1, however, the cigarette has a length of about 98 mm, wherein the length of the tobacco rod is about 67 mm and the length of the filter element is 31 mm. The cellulose acetate tow item is 3.6 denier per filament/31000 total denier, and is plasticized using triacetin. The filter tow material is wrapped with a 0.91 inch width of carbon-containing paper plug wrap, as is described in Example 1. The paper wrapper of the tobacco rod is available as Ref. No. 453 from Ecusta Corp. The cigarette is not air diluted.

EXAMPLE 5

Cigarettes are provided essentially as described in Example 4; however, the cigarette is air diluted to a level of 25 percent air dilution by providing a ring of perforations in the filter element about 13 mm from the extreme mouthend of the cigarette.

EXAMPLE 6

Cigarettes are provided essentially as described in Example 5; however, the cigarettes are air diluted to a level of 50 percent air dilution.

EXAMPLE 7

A cigarette commercially available "Capri" from Brown & Williamson Tobacco Corp. is provided. The cigarette has a length of about 97 mm, wherein the length of the tobacco rod is about 70 mm and the length of the filter element is about 27 mm. The circumference of the cigarette is about 17 mm. The cellulose acetate tow of the filter element is carefully removed from the cigarette, wrapped with a 0.71 inch width of the carbon-containing paper described in Example 4, and the resulting filter element is inserted back into the cigarette.

EXAMPLE 8

Cigarettes are provided essentially as described in Example 7, but are air diluted by perforating the carbon-containing plug wrap in the air dilution region of the cigarette. The cigarettes are air diluted to air dilution levels of 25 percent and 50 percent.

EXAMPLE 9

A cigarette commercially available as "Merit Ultima" from Philip Morris Inc. is provided. The cigarette has a length of about 99 mm, wherein the length of the tobacco rod is about 68 mm and the length of the filter element is about 31 mm. The circumference of the cigarette is about 24.4 mm. The filter element has two longitudinally positioned segments, and one of those filter segments is concentric. The mouthend filter segment has a length of 7 mm, and the concentric segment has a length of 20 mm. The filter element is removed from the cigarette, as described in Example 7. The inner filter portion or core portion of the concentric segment is removed from the sheath portion, and the outer paper wrap of the core segment is removed and replaced with a 0.75 inch width of the carbon-containing paper described in Example 4. The core portion so provided is inserted into the sheath portion, and the cigarette is reassembled. The cigarette maintains its air dilution level of about 60 percent air dilution.

EXAMPLE 10

Cigarettes are provided essentially as described in Example 9; however, the air dilution perforations in the tipping paper are covered with adhesive tape to provide an essentially non-air diluted cigarette.

EXAMPLE 11

Cigarettes are provided essentially as described in Example 1; however, the carbon-containing paper used as the plug wrap is replaced by a paper containing about 50

parts softwood pulp and about 50 parts molecular sieve granules, which paper is available as ABS-50 from Kimberly-Clark Corp.

EXAMPLE 12

Cigarettes are provided essentially as described in Example 9; however, the carbon-containing paper used as the wrap of the core filter segment is replaced by the paper available as ABS-50 from Kimberly-Clark Corp.

As described for the first, second and third embodiments of FIGS. 1-5, incorporation of carbon in the filter of filter cigarettes has been previously shown to be effective in removing or reducing vapor phase compounds in cigarette smoke, by specific adsorption on its active sites. Ventilation on the other hand, results in overall reduction of the gas phase components by diluting the whole cigarette smoke with air. Thus, a 50% ventilation results in a 50 % average reduction of all gas phase compounds. A combination of carbon filter and high ventilation results in tremendous reduction in the gas phase of cigarette smoke, not only because of the additive effect, but also because air dilution increases the removal efficiency of carbon filter by increasing the residence time of the smoke in the filter. However, filters that combine the two features are complex in design and require several steps in manufacturing. The filter elements disclosed in the fourth, fifth, sixth and seventh embodiments of FIGS. 6-10 achieve this objective while keeping the configuration simple, and therefore are relatively easy to manufacture.

FIG. 6 shows a fourth embodiment of a cigarette 110 having a filter element 130 of cellulose acetate tow 131 with grooves 132 disposed around the periphery thereof. The grooves 132 extend from the end of the filter element 130 that abuts the rod 115 of smokable material 120, substantially (but not entirely) along the length of the filter element 130.

FIGS. 7-9 show various cross sections taken through filter element 130. FIG. 7 illustrates a single plug wrap 134 of a carbon-containing paper. A channel 133 is formed by grooves 132 and plug wrap 134 and directs cigarette smoke along the outer periphery of the filter element 130 and then back through the porous cellulose acetate tow which comprises the filter element 130. FIG. 8 is an embodiment in which a carbon-containing paper wrap 136 is provided, covered by a non-carbon-containing plug wrap 138. FIG. 9 is a further embodiment in which the smoke channel 133 is provided with a carbon-containing paper on all sides of the channel. Specifically, an inner layer 140 of carbon-containing paper is wrapped about filter element 130 with the paper contoured to fit within grooves 132. A second, outer layer 142 of carbon-containing paper is wrapped about filter element 130, overwrapping inner layer 140. However, the outer layer 142 is not contoured to fit within grooves 132. A layer 144 of plug wrap is then wrapped about outer layer 142. FIG. 10 shows a seventh embodiment similar to the embodiment of FIG. 6, but with the grooves 152 running the entire length of filter element 150. In such an embodiment, the smoke does not reenter the cellulose acetate tow, but exits the mouthpiece end of the filter element 150. Air dilution in each of the embodiments of FIGS. 6-10 can be provided by providing a perforation in each channel, similar to that shown in FIGS. 1-5.

The materials comprising the embodiments shown in FIGS. 6-10 are similar to those in the embodiments of FIGS. 1-5, with the differences noted below.

The function and operation of the filter embodiments of FIGS. 6-9 are as follows with the operation of the embodiment of FIG. 10 being similar: The filter 130 comprises a high efficiency cellulose acetate tow, formed into a rod with a high level of plasticizer, such as triacetin. The type of tow and type/level of plasticizer are adjusted such that the tow is almost impervious to cigarette smoke. The imperviousness of the filter 130 can also be achieved by a variety of other means, such as steam-bonding the cellulose acetate fiber. However, in some applications, a filter rod with lower efficiency may be desired. The surface of the filter rod is equipped with grooves 132 or other raised patterns. The depth, shape and number of grooves 132 are adjusted to achieve a differential pressure drop across the channels such that the majority of the smoke preferentially flows through the channel 133 instead of through the tow. In some cases, grooves or a pattern (not shown) may cover the entire length of the filter (FIG. 10), whereas in others, the grooves may cover only a partial length of the filter plug (FIG. 6). The rod is overwrapped with a paper having a low porosity and heavily filled with adsorbent like activated carbon. The activated carbon paper encloses the grooves 132, thereby forming longitudinal channels 133, and provides capillary pathways that carry the smoke from the tobacco end to the mouthend of the filter. Passage of the smoke through the capillary pathways creates a pressure drop without any significant filtration. The number and depth/shape of the channels determine the pressure drop. The particular configuration of the filter, forces the majority of the smoke to flow parallel to the surface of the carbon and in its close proximity, such that the lighter vapor phase molecules, which have a larger mean-free pathway than the heavier aerosol particles, are forced to react with the carbon surface, resulting into its adsorption on the active sites. For incorporation in the paper matrix, particle size of the carbon or other adsorbent is selected such that the maximum number of active sites are exposed on the surface. The channels 133 can be designed for maximum adsorption of the gas phase molecules without having any significant impact on the tar phase containing larger and heavier molecules. In cases where an embossed pattern covers the entire length of the filter, a low-efficiency cellulose acetate filter with carbon paper as plug wrap may serve as a mouthend cap.

Examples of the embodiments of FIGS. 6-9 were prepared.

Filter rods were made with 1.6/48,000 dpf cellulose acetate tow and 9% triacetin as plasticizer. Five grooves 132, equally spaced around the circumference were made with an electronic soldering iron on a 31 mm segment of the filter. The grooves were 1 mm deep and 26 mm in length leaving 5 mm length without grooves. The filter was overwrapped with a paper containing 50% activated carbon. Tow was removed from a Camel Lt. 100 cigarette and the experimental filter was inserted into the cavity. The resulting cigarette was air-diluted to 50% by making a row of perforations with a 32 G needle at 20 mm from the mouthend. The air diluted cigarette had a pressure drop of 95 mm of water. Compared to control the cigarette was smoother with less harshness and the aerosol delivery was 10 mg when smoked under FTC conditions. These examples are shown as Examples 13 and 14 in the following table:

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	EXAMPLE 13	EXAMPLE 14
FILTER DESCRIPTION	ONE-PIECE	TWO PIECE
LENGTH	31 mm	31 mm
CIRCUMFERENCE	24.43 mm	24.43 mm
PLUG WRAP	C-PAPER SLIT WIDTH 26.5 mm CORE SIZE 3" I.D. POROSITY 6.75 CORESTA CALIPER .1438 inch BASIS WT. 65 g/m²	C-PAPER SLIT WIDTH 26.5 mm CORE SIZE 3" I.D. POROSITY 6.75 CORESTA CALIPER .1438 inch BASIS WT. 65 g/m²
GROOVED SEGMENT	24 mm	24 mm
NO. OF GROOVES	6	6
DEPTH OF GROOVES	VARIES WITH GROOVE CONFIGURATION	VARIES WITH GROOVE CONFIGURATION
UN-GROOVED SEG.	7 mm	7 mm
PRESSURE DROP, WHOLE FILTER	60–75 mm (WATER)	60–75 mm (WATER)
PRESSURE DROP, GROOVES	40–55 mm (WATER)	40–55 mm (WATER)
PRESSURE DROP, END CAP	5–20 mm (WATER)	5–20 mm (WATER)

An eighth embodiment of a filter having essentially randomly arranged flow channels formed by the carbon-containing paper and filled with a non-carbon-containing filter material such as cellulose acetate tow is shown in FIGS. 11–12. Therein, a cigarette 210 having a two-part filter 230 attached to a smokable rod 215 is illustrated. A mouthpiece 231 is attached by tipping material to a so-called "carbon ripple filter" (CR) segment 232. Carbon ripple filter segment 232 is so named because of the somewhat random, rippled appearance of the filter as shown in cross-section in FIG. 12. Filter segment 232 is formed by the simultaneous gathering into a cylindrical segment of a non-carbon-containing web 234 of cellulose acetate, polypropylene or polyester with a carbon-containing paper 236, as in an apparatus described in U.S. Pat. No. 4,807,809 to Pryor et al. Plug wrap 238 overwraps the gathered materials 234, 236. Ventilation holes 240 are provided circumferentially around the periphery of the mouthpiece 231, as shown in FIG. 11. The dimensions of the smokable rod 215 are similar to those described in the prior embodiments. The filter segments can be typically 12 mm for the carbon-containing segment 232 and 15 mm for the mouthpiece 231. The carbon containing paper 236 is typically 50% carbon in the form of activated coconut carbon available as PCB ground carbon having an average particle size of 40 microns, available from Calgon Carbon Corporation, Pittsburgh, Pennsylvania. Alternatively, the non-carbon- containing material may be tacked to the carbon-containing paper by applying a glue or adhesive or by bringing the web into contact with the carbon-containing paper while the web is still tacky from manufacture. Although not shown, it is contemplated that the mouthpiece 231 can be eliminated and only a carbon-containing segment of suitable length be provided having ventilation holes therein, as necessary.

In operation, this embodiment is similar to the filter described in U.S. Ser. No. 898,111, filed Jun. 12, 1992. That

filter has channels that allow tar particles to pass through the filter with little or no interaction with the carbon paper) thus, resulting in little or no carbon off-taste. However, gas phase particles, due to their rapid diffusion, contact the side walls of the channels, interact with carbon and are adsorbed. Due to the channels in the aforementioned filter, there is no pressure drop associated with this portion of the filter. In the eighth embodiment, cellulose acetate, polypropylene web, polyester web, or some other appropriate material is gathered with the carbon paper resulting in a filter with the channels filled with a tar filtering media. This allows for pressure drop to be added to a filter segment with little or no taste impact to the filter. Since the regions of lowest pressure drop will still be through the tow or other non-carbon filter material (as opposed to through the edge of the carbon paper) tar will still pass into the channels, but will be filtered. Using the appropriate pressure drop (which can be varied, as appropriate) in a filter according to this embodiment allows it to be combined with a low pressure drop mouth end segment made of appropriate material which can result in a clean end appearance. Filters according to this embodiment having differing pressure drops can also be combined with regular cellulose acetate to aid in phenol removal and/or tar reduction. Typically, the pressure drop is in the range of 30–90 psig, and preferably from 50–75 psig.

Typical carbon ripple relative web sizes are contemplated as follows:

Carbon Paper Web (inches)	Melt Blown Polypropylene Web (inches)	Polyester Web (inches)
4.25	5.0	
4.25	7.0	
4.25		5.0
4.25		7.0
4.25		4.25

EXAMPLE 15

A cigarette in accordance with the present embodiment is made having a smokable rod of flue cured tobacco and a filter having a 12 mm carbon-containing segment of gathered 4.25 inch carbon paper web and a 5.0 inch polyester web with a 15 mm mouthpiece made of polypropylene sheet. Air dilution holes were arranged around the periphery of the mouthpiece segment at a location 13 mm from the end of the mouthpiece. Such cigarettes have a tar yield of 10 mg. but have significantly reduced condensable vapor phase smoke components as compared to a 10 mg. tar product with a standard cellulose acetate filter.

Although certain presently preferred embodiments of the invention have been specifically illustrated and described herein, it will be appreciated by those skilled in the art to which the invention pertains that many modifications and variations of the present invention are possible in light of the above teachings without departing from the spirit and scope of the invention. Accordingly, it is intended that the invention be limited only to the extent required by the appended claims and the applicable rules of law.

What is claimed is:

1. A cigarette having a charge of smokable material including tobacco cut filler wrapped in a circumscribing wrapping material to form a smokable rod; the cigarette comprising a filter element positioned adjacent one end of the smokable rod; the filter element including filter material

having a plurality of longitudinal grooves therein and circumscribed by a carbon-containing paper material.

2. The cigarette of claim 1 wherein the paper includes more than about 20 weight percent carbonaceous material, based on the dry weight of the paper.

3. The cigarette of claim 1 wherein the paper includes more than about 30 weight percent carbonaceous material, based on the dry weight of the paper.

4. The cigarette of claim 1 wherein the carbonaceous material within the filter element is an amount of about 25 to about 75 mg.

5. The cigarette of claim 1, wherein the paper consists essentially of wood pulp and carbonaceous material.

6. The cigarette of claim 1, wherein the carbon-containing paper material is contoured so as to fit within said grooves.

7. The cigarette of claim 6, wherein a layer of carbon-containing paper is wrapped over the contoured paper material so as to form a longitudinal channel.

8. The cigarette of claim 1, wherein a noncarbon-containing plug wrap layer is wrapped over said carbon-containing paper material.

9. The cigarette of claim 7, wherein a noncarbon-containing plug wrap layer is wrapped over said second layer.

10. A cigarette having a charge of smokable material including tobacco cut filler wrapped in a circumscribing wrapping material to form a smokable rod; the cigarette comprising a filter element positioned adjacent one end of the smokable rod; the filter element including a carbon-containing paper material randomly gathered with a web of filter material different from said carbon-containing paper material and from said smokable material, thereby forming randomly oriented flow paths having carbon-containing paper therein.

11. The cigarette according to claim 10, wherein the carbon-containing paper includes approximately 50 weight percent carbonaceous material, based on the dry weight of the paper.

12. The cigarette according to claim 10, wherein the web of filter material is polypropylene.

13. The cigarette according to claim 10, wherein the web of filter material is polyester.

14. The cigarette according to claim 10, wherein the filter element includes a non-carbon-containing mouthpiece segment and a carbon-containing segment.

15. The cigarette according to claim 14, wherein the mouthpiece segment includes a plurality of ventilation holes arranged circumferentially around the outer periphery of the mouthpiece segment.

16. A cigarette having a charge of smokable material including tobacco cut filler wrapped in a circumscribing wrapping material to form a smokable rod; the cigarette comprising a filter element positioned adjacent one end of the smokable rod; the filter element including filter material circumscribed by a molecular sieve-containing paper material.

17. A cigarette having a charge of smokable material including tobacco cut filler wrapped in a circumscribing wrapping material to form a smokable rod; the cigarette comprising a filter element positioned adjacent one end of the smokable rod; the filter element including filter material having a plurality of longitudinal grooves therein and circumscribed by a molecular sieve-containing paper material.

18. A cigarette having a charge of smokable material including tobacco cut filler wrapped in a circumscribing wrapping material to form a smokable rod; the cigarette comprising a filter element positioned adjacent one end of the smokable rod, said filter element having a circumferential peripbery; the filter element including filter material having a plurality of longitudinal grooves therein and located around said periphery and circumscribed by a carbon-containing paper material.

19. A cigarette having a charge of smokable material including tobacco cut filler wrapped in a circumscribing wrapping material to form a smokable rod; the cigarette comprising a filter element positioned adjacent one end of the smokable rod and having a cross-section; the filter element including a carbon-containing paper material randomly gathered with a web of filter material different from said carbon-containing paper material and from said smokable material, thereby forming randomly oriented flow paths disposed throughout the cross-section of the filter element and having carbon-containing paper therein.

* * * * *

51696 1017

US005404890A

United States Patent [19]

Gentry et al.

[11] **Patent Number:** 5,404,890

[45] **Date of Patent:** Apr. 11, 1995

[54] CIGARETTE FILTER

[75] Inventors: Jeffery S. Gentry, Pfafftown; Karen M. Womble, Winston-Salem; Chandra K. Banerjee; Richard L. Blakley, both of Pfafftown, all of N.C.

[73] Assignee: R. J. Reynolds Tobacco Company, Winston-Salem, N.C.

[21] Appl. No.: 76,711

[22] Filed: Jun. 11, 1993

[51] Int. Cl.6 .... A24D 3/00; A24D 1/02

[52] U.S. Cl. 131/342; 131/361; 131/365

[58] Field of Search 131/342, 344, 361, 365, 131/339, 331

[56] References Cited

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Primary Examiner—Jennifer Bahr

[57] **ABSTRACT**

A cigarette includes a filter element including a carbon-containing paper or a paper containing molecular sieves. The paper circumscribes filter material, such as cellulose acetate tow, within the filter element. The paper is useful as a plug wrap for a filter element.

9 Claims, 1 Drawing Sheet

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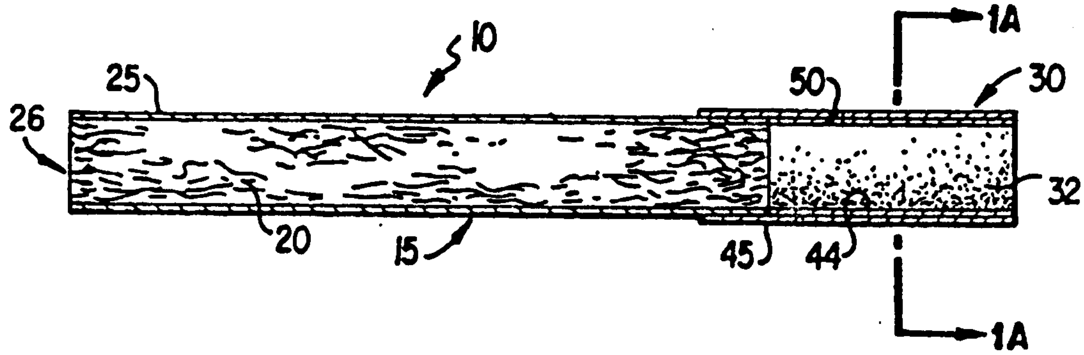
Date: 5-21-97
Rptr: BB



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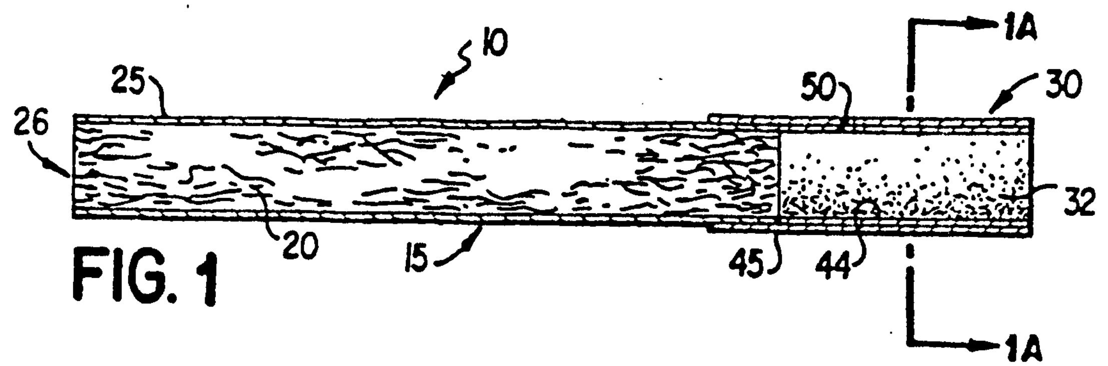

FIG. 1

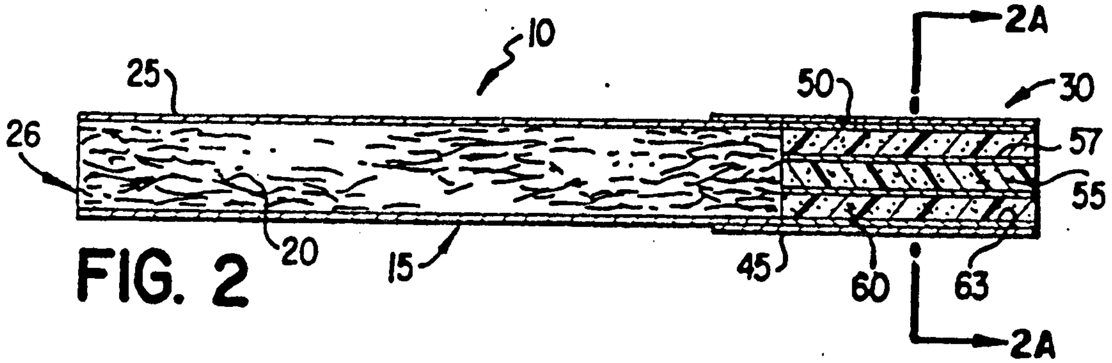

FIG. 2

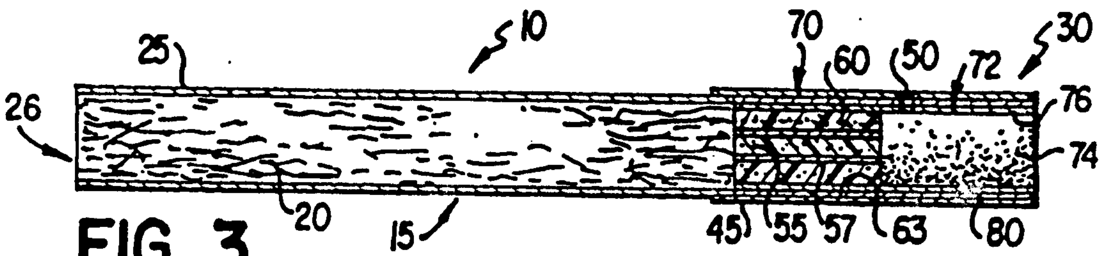

FIG. 3

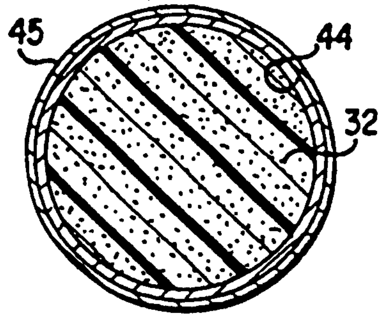

FIG. 1A

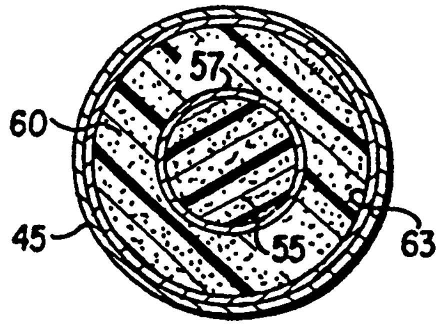

FIG. 2A

the cigarette. See, Selke, et al., *Beitr. Zur Tabak. In.*, Vol. 4, p. 193 (1978).

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 through 3 are longitudinal sectional views of cigarettes of the present invention; and

FIGS. 1A and 2A are enlarged cross-sectional radial views of the cigarettes shown in FIGS. 1 and 2 taken along lines 1—1 in FIG. 1 and line 2—2 in FIG. 2.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

One preferred embodiment of a cigarette of the present invention is shown in FIG. 1. Cigarette 10 includes a generally cylindrical rod 15 of smokable material 20, such as tobacco cut filler, contained in a circumscribing wrapping material 25. The rod 15 hereinafter referred to as a "tobacco rod." The ends of the tobacco rod 15 are open to expose the smokable material. The tobacco rod is used by lighting one end thereof, and aerosol (e.g., smoke) is provided as a result of the combustion of the burning smokable material 20, which is lit at lighting end 26. As such, the tobacco rod burns back from the lit end thereof towards the opposite end (i.e., mouthend) thereof, and the smokable material of the tobacco rod is consumed by combustion during the smoking period.

The cigarette 10 also includes a filter element 30 positioned adjacent one end of the tobacco rod 15 such that the filter element and tobacco rod are axially aligned in an end-to-end relationship, preferably abutting one another. Filter element 30 has a generally cylindrical shape, and the diameter thereof is essentially equal to the diameter of the tobacco rod. The ends of the filter element are open to permit the passage of air and smoke therethrough.

Filter element 30 includes a filter material 32 (e.g., starch-based, polypropylene, or plasticized cellulose acetate tow) circumscribed by plug wrap 44. The filter material also can have the form of a gathered web (e.g., polypropylene web, polyester web or starch-based web), which is gathered using techniques such as are described in U.S. Pat. No. 4,870,809 to Pryor et al. If desired, the filter material can have at least one tubular capillary, passage or groove (not shown) extending longitudinally therethrough or partially therethrough. The plug wrap 44 is a paper which incorporates a carbonaceous material. The plug wrap circumscribes the total length of the filter element.

The filter element 30 is attached to the tobacco rod 15 by tipping material 45 which circumscribes both the entire length of the filter element and an adjacent region of the tobacco rod. The inner surface of the tipping material 45 is fixedly secured to the outer surface of the plug wrap 44 and the outer surface of the wrapping material 25 of the tobacco rod, using a suitable adhesive. A ventilated or air diluted smoking article is provided with an air dilution means, such as a series of perforations 50, each of which extend through the tipping material and plug wrap.

Referring to FIG. 2, another embodiment of a cigarette 10 of the present invention is shown. The cigarette shown in FIG. 2 is generally similar to that cigarette described with reference to FIG. 1. However, the filter element 30 includes an inner core of filter material 55 (e.g., gathered paper, gathered polyolefin web, gathered polyester web or cellulose acetate tow) circumscribed by paper wrap 57. As such, the filter element is concentric in configuration. The paper wrap 57 is a paper which most preferably incorporates a carbonaceous material. The paper wrap 57 has the form of a tube which extends from one end of the filter element to the other. The paper wrap 57 is circumscribed by filter material 60, which is in turn circumscribed by plug wrap 63. The plug wrap 63 can be a conventional paper plug wrap material or a paper which incorporates a carbonaceous material. The filter material 60 which forms a sheath can be a gathered paper, cellulose acetate tow, gathered polyolefin (e.g., polyethylene or polypropylene) web or a gathered polyester web. Preferably, the core filter material is different in character or composition from the outer sheath material. The filter material also can be provided from a plasticized, non-wrapped cellulose acetate filter rod, such as is available from American Filtrona Corp. One example of a suitable filter element is one having a core region of a cellulose acetate tow item of 1.6 denier per filament/48000 total denier and a sheath region of a cellulose acetate tow item of 8.0 denier per filament/40000 total denier, wherein either or both of the filter materials can be circumscribed by a carbon-containing paper.

Referring to FIG. 1A, a cross-sectional view of the filter element described with reference to FIG. 1 is shown. As such, the plug wrap 44 appears as a black ring around the filter material 32.

Referring to FIG. 2A, a cross-sectional view of the filter element described with reference to FIG. 2 is shown. As such, the plug wrap 63 which incorporates a carbonaceous material appears as a black ring around filter material 60, and paper wrap 57 appears as a black ring between filter materials 55 and 60.

Referring to FIG. 3, another embodiment of a cigarette 10 of the present invention is shown. The cigarette shown in FIG. 3 is generally similar to that cigarette described with reference to FIG. 2. However, the filter element 30 includes two longitudinally positioned segments, a first segment 70 which is generally similar to that filter element described with reference to FIG. 2 (i.e., there are at least two tubes of paper containing carbonaceous material positioned within that segment), and a second segment 72 which includes a filter material 74 and a circumscribing plug wrap 76. The plug wrap 76 can be a conventional paper plug wrap material or a paper which incorporates a carbonaceous material. Alternatively, the first segment 70 can be generally similar to the filter element described with reference to FIG. 1. If desired, the first filter segment can have at least one tubular capillary or passage (not shown) extending longitudinally therethrough. Typically, such a passageway which extends through the first filter segment is provided from a narrow tube of cellulose acetate, polyethylene, polypropylene, or other plastic material. Typically, such a tube has an inner diameter of about 0.01 to about 0.06 inch, and usually about 0.03 to about 0.04 inch. If desired, the filter material of the first segment can contain flavoring agents and certain other additives, such as is described in U.S. patent application Ser. No. 945,042, filed Sep. 15, 1992. Typically, the first and second filter segments are different in length and/or composition of components. The two filter segments are longitudinally disposed relative to one another such that the first segment 70 is positioned adjacent one end of the tobacco rod, and the second segment 72 is positioned adjacent one end of the first segment and at the extreme mouthend of the cigarette. The two segments are maintained in an abutting end-to-end relationship by a circumscribing outer plug wrap material 80. Such

Typically, corrugations can be in the form of ridges spaced about 1 mm to about 2 mm, and often about 1.5 mm to about 1.7 mm apart and about 0.1 to about 1 mm, often about 0.7 mm to about 0.9 mm deep. When such a corrugated plug wrap is employed, the cigarette can be air diluted by perforating the tipping paper, but not perforating the plug wrap in order that the air which dilutes the smoke during draw experiences a tendency to pass through the air flow passageways between the tipping paper and plug wrap and into the mouth of the smoker. Representative concentric filters which can be modified so as to have the carbon-containing paper incorporated therein are described in European Patent Application No. 474,940.

The amount of carbonaceous material incorporated within a carbon-containing paper can vary. Typically, the amount of carbonaceous material within such paper is more than about 15, usually more than about 20, generally more than about 25, often more than about 30, and frequently, more than about 40 weight percent, based on the dry weight of the paper. Typically, the amount of carbonaceous material within such paper is less than about 65, often less than about 60 and frequently less than about 55 weight percent, based on the dry weight of the paper. Similar amounts of the other materials capable of absorbing and/or adsorbing gas phase components from cigarette smoke also can be incorporated into the paper in place of the carbonaceous material.

The amount of carbonaceous material within the filter segment containing the gathered paper containing that material typically ranges from about 20 to about 120 mg, often about 40 to about 110 mg, and frequently about 60 to about 100 mg. Similar amounts of the other materials capable of absorbing and/or adsorbing gas phase components from cigarette smoke also can be incorporated into the paper in place of the carbonaceous material.

Typically, the weight of carbon-containing paper or similar paper within the filter segment incorporating that paper ranges from about 75 to about 250 mg, generally about 100 to about 225 mg and often about 125 to about 200 mg.

The carbonaceous material which is incorporated into the filter element can vary. Most preferred carbonaceous materials are highly activated. The degree of activation can vary, and typically is such so as to provide about 25 to about 125, more typically about 60 to about 70, weight percent pickup of carbon tetrachloride. Carbonaceous materials most useful herein have a high carbon content; consist primarily of carbon; and preferably have a carbon content above about 80 weight percent, and more preferably above about 90 weight percent. Preferred carbonaceous materials are provided by carbonizing or pyrolyzing bituminous coal, tobacco material, softwood pulp, hardwood pulp, coconut hulls, kapok fibers, cotton fibers, cotton liners, and the like. Examples of suitable carbonaceous materials are activated coconut hull based carbons available from Calgon Corp. as PCB, PCBG and GRC-11. Examples of suitable carbonaceous materials are coal based carbons available from Calgon Corp. as S-Sorb, BPL, CRC-11F, FCA and SGL. Examples of suitable carbonaceous materials are wood based carbons available from Westvaco as WV-B, SA-20 and BSA-20. Other carbonaceous materials are available from Calgon Corp. as HMC, ASC/GR-1 and SC II. Another carbonaceous material includes Witco Carbon No. 637. Other carbonaceous materials are described in U.S. patent application Ser. No. 07/569,325, filed Aug. 17, 1990; U.S. Pat. Nos. 4,771,795 to White, et al. and 5,027,837 to Clearman, et al.; and European Patent Application Nos. 236,922; 419,733 and 419,981. Certain carbonaceous materials, which can be activated, can be impregnated with substances such as silver, copper, platinum, palladium, potassium bicarbonate, tobacco extracts, menthol, polyethyleneimine, manganese dioxide, chromate salts, eugenol, and 4-ketononanoic acid.

The size of the individual carbonaceous powder, particles or granules can vary, depending upon the desired design of the filter element. The individual powdered or fine grain carbonaceous particles typically have a diameter of about 10 μm to about 250 μm, often about 20 μm to about 100 μm, and frequently about 30 μm to about 70 μm. Particularly preferred powdered or fine grain particles can be characterized as having an average diameter of about 40 μm, or such that 90 percent of the particles or fine grains pass through a 325 U.S. mesh screen. The materials which are incorporated into the paper in place of the carbonaceous material can have similar particle sizes.

The carbon-containing paper includes other materials. The paper includes at least one cellulosic material, can include at least one inorganic filler, and can include other additives or ingredients employed in the paper making industry. Exemplary cellulosic materials include flax fibers, hardwood pulp (preferably unbleached), softwood pulp (preferably unbleached), cotton fibers, tobacco parts (e.g., tobacco laminae and stem pieces), and the like. Exemplary inorganic filler materials include molecular sieve particles, agglomerated calcium carbonate particles, calcium carbonate particles, calcium sulfate fibers, precipitated magnesium hydroxide gel, clay particles, and the like. Most preferably, the materials which make up the paper are incorporated into the paper during manufacture using the paper making process. Components such as sizing agents and moisture also can be incorporated into the carbon-containing paper. Typically, the amount of sizing agent incorporated into the paper is less than about 5 weight percent, and often about 0.1 to about 3 weight percent; and the moisture content of the paper ranges from about 5 to about 15 weight percent, and often about 8 to about 12 weight percent. Flavoring agents and other smoke modifying agents (e.g., tobacco extracts, heat treated tobacco extracts, spearmint, vanillin, anethole and menthol) also can be incorporated into the carbon-containing paper. Exemplary tobacco extracts are spray dried extracts and are described in U.S. Pat. No. 5,060,669 to White et al. A preferred carbon-containing paper consists essentially of softwood pulp and carbonaceous material. Certain carbon-containing papers are absent of tobacco material. Certain carbon-containing papers are absent of inorganic fillers (e.g., calcium carbonate particles), and are absent of thermoplastic fibers (e.g., polyethylene, polypropylene or polyester fibers).

The physical properties of the carbon-containing paper or similar types of papers can vary. The thickness of the paper typically ranges from about 0.08 mm to about 0.2 mm, often about 0.13 mm to about 0.18 mm. The basis weight of the paper typically ranges from about 35 g/m² to about g/m², often about 45 g/m² to about 55 g/m². The tensile strength of the paper preferably is at least about 800 g/in, typically ranges from about 1100 g/in to about 2300 g/in, although papers having greater tensile strengths can be employed. The

total denier) plasticized using triacetin and circumscribed by a 0.98 inch width of carbon-containing paper available as XCCW/KCG-50 or P-144-KGG-50 from Kimberly-Clark Corp. Such a paper is made of about 50 parts carbon, about 50 parts wood pulp. The filter element is made by wrapping the paper wrap around the length of the cylindrical segment of filter material.

The smokable material is an American blend of fluecured, Burley, Oriental, reconstituted and volume expanded tobaccos in cut filler form. The blend has been cased and top dressed. The paper wrapper of the tobacco rod is available as Ref. No. 456 from Miguel y Costas.

The filter element is attached to the tobacco rod using paper tipping material. The cigarette is not air diluted.

EXAMPLE 2

Cigarettes are provided essentially as described in Example 1; however, the cigarette is air diluted to a level of 25 percent air dilution by providing a ring of perforations in the filter element about 13 mm from the extreme mouthend of the cigarette.

EXAMPLE 3

Cigarettes are provided essentially as described in Example 2; however, the cigarettes are air diluted to a level of 50 percent air dilution.

EXAMPLE 4

Cigarettes are provided, essentially as described in Example 1. However, the cigarette has a length of about 98 mm, wherein the length of the tobacco rod is about 67 mm and the length of the filter element is 31 mm. The cellulose acetate tow item is 3.6 denier per filament/31000 total denier, and is plasticized using triacetin. The filter tow material is wrapped with a 0.91 inch width of carbon-containing paper plug wrap, as is described in Example 1. The paper wrapper of the tobacco rod is available as Ref. No. 453 from Ecusta Corp. The cigarette is not air diluted.

EXAMPLE 5

Cigarettes are provided essentially as described in Example 4; however, the cigarette is air diluted to a level of 25 percent air dilution by providing a ring of perforations in the filter element about 13 mm from the extreme mouthend of the cigarette.

EXAMPLE 6

Cigarettes are provided essentially as described in Example 5; however, the cigarettes are air diluted to a level of 50 percent air dilution.

EXAMPLE 7

A cigarette commercially available as "Capri" from Brown & Williamson Tobacco Corp. is provided. The cigarette has a length of about 97 mm, wherein the length of the tobacco rod is about 70 mm and the length of the filter element is about 27 mm. The circumference of the cigarette is about 17 mm. The cellulose acetate tow of the filter element is carefully removed from the cigarette, wrapped with a 0.71 inch width of the carbon-containing paper described in Example 4, and the resulting filter element is inserted back into the cigarette.

EXAMPLE 8

Cigarettes are provided essentially as described in Example 7, but are air diluted by perforating the carbon-containing plug wrap in the air dilution region of the cigarette. The cigarettes are air diluted to air dilution levels of 25 percent and 50 percent.

EXAMPLE 9

A cigarette commercially available as "Merit Ultima" from Philip Morris Inc is provided. The cigarette has a length of about 99 mm, wherein the length of the tobacco rod is about 68 mm and the length of the filter element is about 31 mm. The circumference of the cigarette is about 24.4 mm. The filter element has two longitudinally positioned segments, and one of those filter segments is concentric. The mouthend filter segment has a length of 7 mm, and the concentric segment has a length of 20 mm. The filter element is removed from the cigarette, as described in Example 7. The inner filter portion or core portion of the concentric segment is removed from the sheath portion, and the outer paper wrap of the core segment is removed and replaced with a 0.75 inch width of the carbon-containing paper described in Example 4. The core portion so provided is inserted into the sheath portion, and the cigarette is reassembled. The cigarette maintains its air dilution level of about 60 percent air dilution.

EXAMPLE 10

Cigarettes are provided essentially as described in Example 9; however, the air dilution perforations in the tipping paper are covered with adhesive tape to provide an essentially non-air diluted cigarette.

EXAMPLE 11

Cigarettes are provided essentially as described in Example 1; however, the carbon-containing paper used as the plug wrap is replaced by a paper containing about 50 parts softwood pulp and abut 50 parts molecular sieve granules, which paper is available as ABS-50 from Kimberly-Clark Corp.

EXAMPLE 11

Cigarettes are provided essentially as described in Example 9; however, the carbon-containing paper used as the wrap of the core filter segment is replaced by the paper available as ABS-50 from Kimberly Clark Corp.

What is claimed is:

1. A cigarette having a charge of smokable material including tobacco cut filler wrapped in a circumscribing wrapping material to form a smokable rod; the cigarette comprising a filter element positioned adjacent one end of the smokable rod; the filter element including filter material different from said smokable material circumscribed by a carbon-containing paper material, said filter material being separate from said carbon-containing paper material.

2. The cigarette of claim 1 wherein the filter element includes at least two longitudinally positioned filter segments, and at least one of those filter segments includes the carbon-containing paper material.

3. The cigarette of claim 1 wherein the paper includes more than about 20 weight percent carbonaceous material, based on the dry weight of the paper.

4. The cigarette of claim 1 wherein the paper includes more than about 30 weight percent carbonaceous material, based on the dry weight of the paper.

51696 1022

US005360023A

United States Patent [19]

Blakley et al.

[11] Patent Number: 5,360,023

[45] Date of Patent: Nov. 1, 1994

[54] CIGARETTE FILTER

[75] Inventors: Richard L. Blakley, Pfafftown; Gary R. Shelar, Greensboro; Jeffery S. Gentry, Pfafftown; Gary W. Worrell, Tobaccoville; Thomas A. Perfetti, Winston-Salem, all of N.C.

[73] Assignee: R. J. Reynolds Tobacco Company, Winston-Salem, N.C.

[21] Appl. No.: 898,111

[22] Filed: Jun. 12, 1992

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 408,433, Sep. 15, 1989, Pat. No. 5,137,034, which is a continuation of Ser. No. 194,696, May 16, 1988, abandoned, and Ser. No. 759,266, Sep. 13, 1991, Pat. No. 5,271,419, which is a continuation-in-part of Ser. No. 414,833, Sep. 29, 1989, Pat. No. 5,074,321.

[51] Int. Cl.[5] A24D 3/04

[52] U.S. Cl. 131/331; 131/342; 131/339

[58] Field of Search 131/331, 342, 341, 335, 131/339, 365; 55/16, 68, 74, 75, 98

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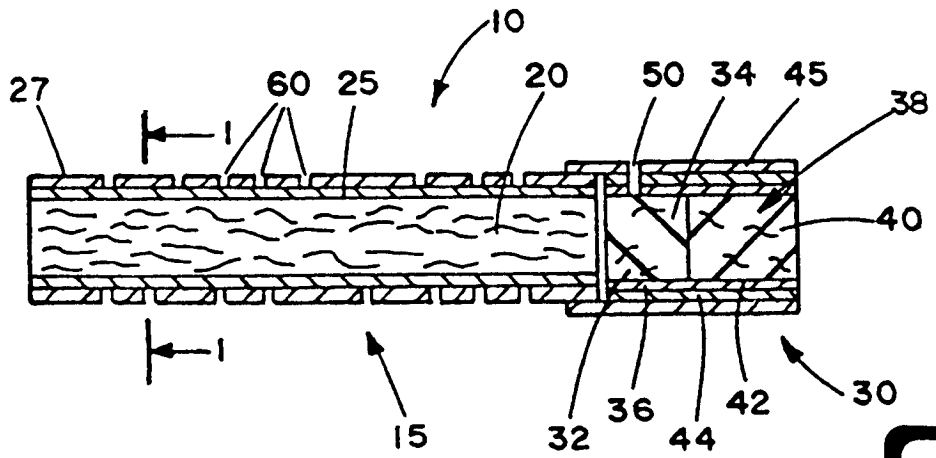
Primary Examiner—Jennifer Bahr

[57] ABSTRACT

Cigarettes include a filter element which have a gathered web of paper incorporating a carbonaceous material. The paper is gathered so as to include a plurality of longitudinally extending channels, and the channels provide a cross-sectional void area of about 5 to about 30 percent of the filter element.

29 Claims, 3 Drawing Sheets



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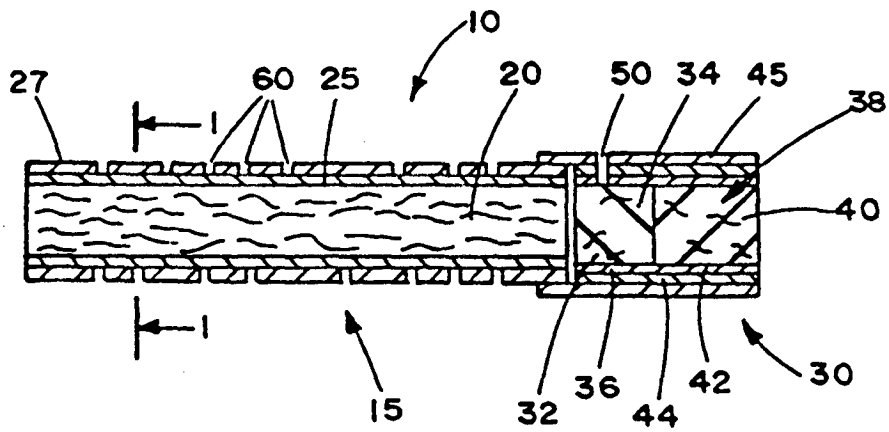

FIG. 1

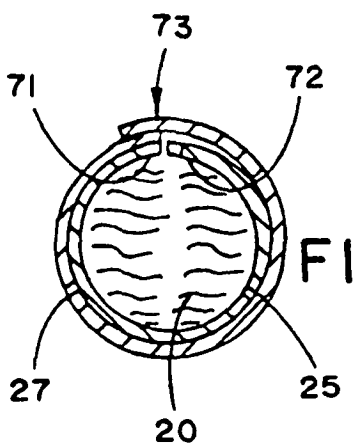

FIG. 1A

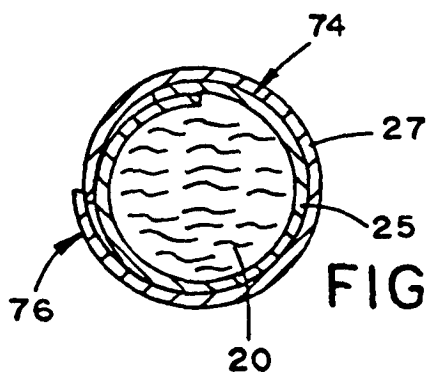

FIG. 1B

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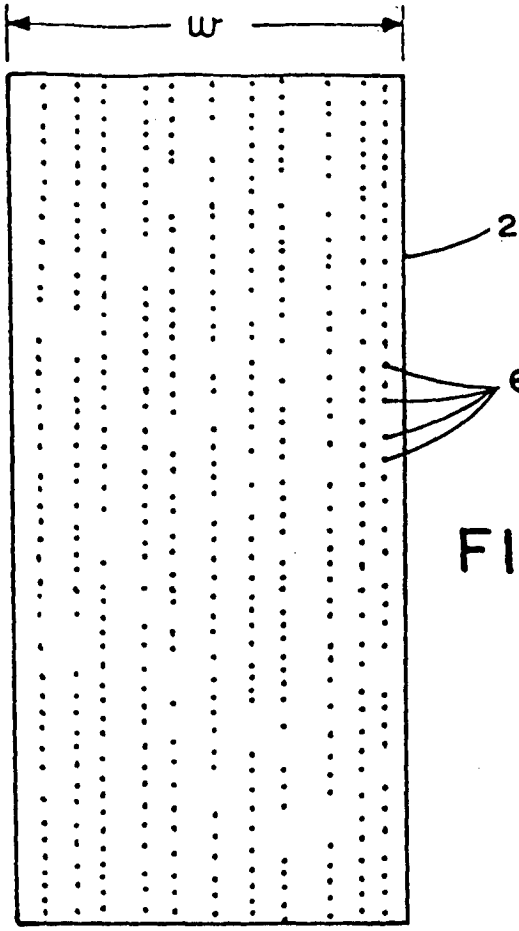

FIG. 2

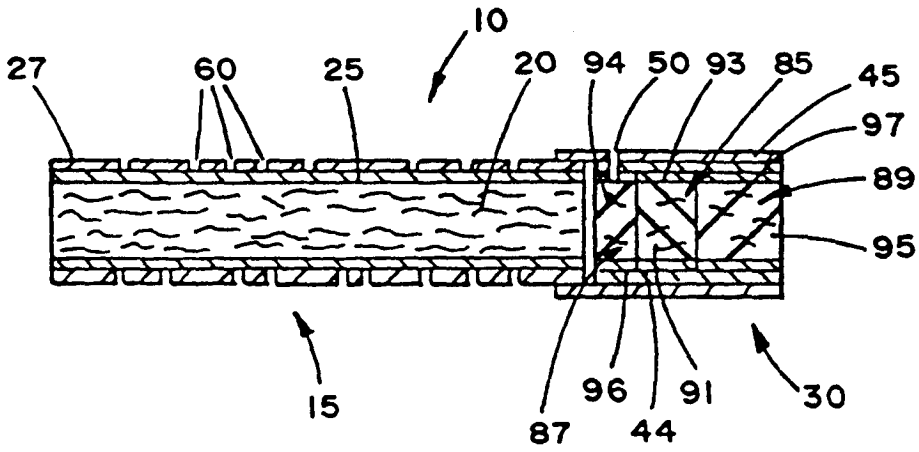

FIG. 3

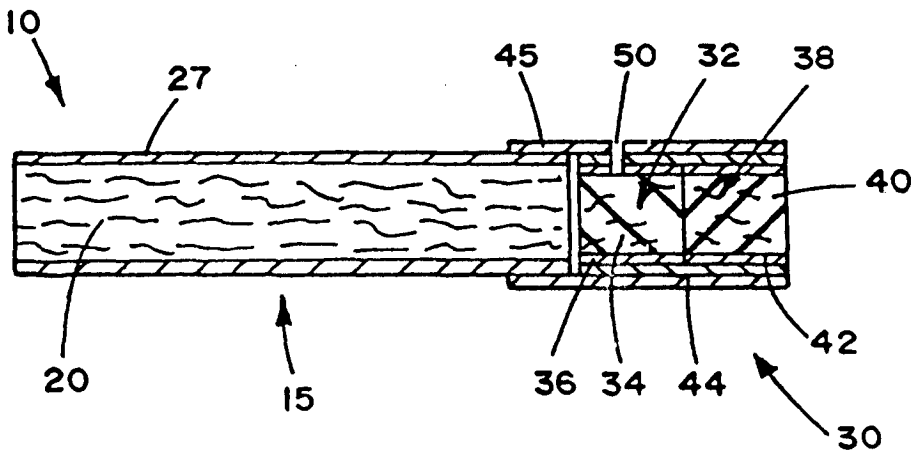

FIG. 4

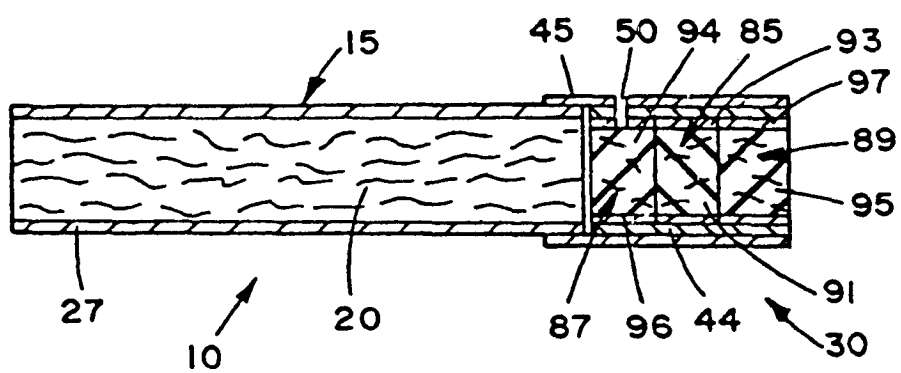

FIG. 5

CIGARETTE FILTER

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of co-pending U.S. patent application Ser. No. 07/408,433, filed Sep. 15, 1989, now U.S. Pat. No. 5,137,034, which is a continuation of U.S. patent application Ser. No. 07/194,696 filed May 16, 1988, now abandoned; and of co-pending U.S. patent application Ser. No. 07/759,266 filed Sep. 13, 1991, now U.S. Pat. No. 5,271,419, which is a continuation-in-part of U.S. patent application Ser. No. 07/414,833, filed Sep. 29, 1989, now U.S. Pat. No. 5,074,321; the disclosures of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates to smoking articles such as cigarettes, and in particular, to cigarettes having filter elements containing a carbonaceous material.

Popular smoking articles, such as cigarettes, have a substantially cylindrical rod shaped structure and include a charge of smokable material such as shredded tobacco (e.g., in cut filler form) surrounded by a paper wrapper thereby forming a so-called "tobacco rod." Normally, a cigarette has a cylindrical filter element aligned in an end-to-end relationship with the tobacco road. Typically, a filter element includes cellulose acetate tow circumscribed by plug wrap, and is attached to the tobacco rod using a circumscribing tipping material. It also has become desirable to perforate the tipping material and plug wrap, in order to provide dilution of drawn mainstream smoke with ambient air.

Cigarettes are employed by the smoker by lighting one end thereof and burning the tobacco rod. The smoker then receives mainstream smoke into his/her mouth by drawing on the opposite end (e.g., the filter end) of the cigarette.

Certain cigarettes have filter elements which incorporate materials such as carbon. Exemplary cigarettes and filters therefor are described in U.S. Pat. Nos. 3,353,543 to Sproull et al. and 4,481,958 to Ranier et al. Certain commercially available filters have particles or granules of carbon (e.g., an activated carbon material or an activated charcoal material) dispersed within cellulose acetate tow; other commercially available filters have carbon threads dispersed therein; while still other commercially available filters have so-called "cavity filter" or "triple filter" designs. Exemplary commercially available filters are available as SCS IV Dual Solid Charcoal Filter from American Filtrona Corp.; Triple Solid Charcoal Filter from FIL International, Ltd.; Triple Cavity Filter from Baumgartner; and ACT from FIL International, Ltd.

Cigarette filter elements which incorporate carbon have a propensity to remove certain gas phase components from the mainstream smoke which passes through the filter element during draw by the smoker. However, aerosol particles of the smoke can have a tendency to interact with the carbon present within such conventional filter elements, thereby causing such aerosol particles to undergo a change in their chemical and physical character or nature. Such a change in the nature or character of aerosol particles of the mainstream smoke results in a change in the organoleptic properties of the mainstream smoke. For example, the mainstream tobacco smoke which is filtered using a conventional cigarette filter element incorporating carbon can often be characterized as having slightly metallic, drying and powdery flavor characteristics.

It would be desirable to provide a cigarette filter element which is capable of removing significant amounts of certain gas phase components of mainstream cigarette smoke, while not adversely affecting the flavor of that mainstream smoke to any significant degree.

SUMMARY OF THE INVENTION

Certain cigarettes of the present invention include a charge or roll of smokable material contained in two layers of circumscribing outer wrapping materials to form a so-called "tobacco rod." The tobacco rod is such that a first (i.e., inner) wrapping material circumscribes the smokable material, and a second (i.e., outer) wrapping material circumscribes the first wrapping material. Certain other cigarettes of the present invention include a charge or roll of smokable material contained in a single layer of circumscribing wrapping material to form a tobacco rod.

The smokable material is a smokable filler material comprising tobacco cut filler material. Normally, the smokable material is all tobacco cut filler material, and preferably that cut filler material has been cased and/or top dressed.

Cigarettes of the present invention each include a filter element which acts as a mouthpiece. The filter element includes a carbonaceous material. The filter element preferably includes two or more filter segments which are longitudinally positioned within the filter element; and at least one of the filter segments includes a carbonaceous material (e.g., an activated carbon material or an activated charcoal material in a powdered or fine grain form). The carbonaceous material preferably is incorporated into the filter segment as a component of a paper (e.g., the paper includes a carbonaceous material as a component thereof). The filter segment including the carbonaceous material is constructed so as to have a plurality of longitudinally extending channels or air passageways extending entirely through that filter segment. The channels or air passageways are of a cross-sectional area such that particulate phase components of mainstream smoke passing through the filter segment are not filtered by or do not interact to a significant degree with the carbonaceous material, while significant amounts of gas phase components of the mainstream smoke can be removed by the carbonaceous material of that filter segment. Typically, the filter segment including the carbonaceous material is provided as a gathered paper web.

Cigarettes optionally can be air diluted (e.g., by perforating the tipping material in the region which overlies the filter elements or by other such air dilution means). When air diluted, the filter element normally is ventilated to provide a cigarette having an air dilution between about 25 and about 75 percent. As used herein, the term "air dilution" is the ratio (expressed as a percentage) of the volume of air drawn through the air dilution means to the total volume of air and smoke drawn through the cigarette and exiting the extreme mouthend portion of the cigarette. See, Selke, et al., *Beitr. Zur Tabak. In.*, Vol. 4, p. 193 (1978).

Filter segments incorporating carbonaceous materials also can be incorporated into those types of cigarettes described in U.S. Pat. No. 5,027,837 to Clearman et al.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a cigarette of the present invention;

FIGS. 1A and 1B are enlarged cross-sectional radial views of two embodiments of the cigarette shown in FIG. 1 taken along line 1—1 in FIG. 1;

FIG. 2 is a diagrammatic illustration of one type of wrapping material which can be employed to provide a tobacco rod of the present invention; and

FIGS. 3–5 are longitudinal sectional views of cigarettes of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

One preferred embodiment of a cigarette of the present invention is shown in FIG. 1. The cigarette 10 includes a generally cylindrical rod 15 of smokable material 20, such as tobacco cut filler, contained in a first circumscribing inner wrapping material 25 and a second or outer wrapping material 27 circumscribing the first wrapping material. The first and second circumscribing wrapping materials directly contact one another (i.e., the inner surface of the outer wrapping material contacts the outer surface of the inner wrapping material). As such, the outer wrapping material overwraps the inner wrapping material. The rod 15 is hereinafter referred to as a "tobacco rod." The ends of the tobacco rod 15 are open to expose the smokable material. The tobacco rod is used by lighting one end thereof, and aerosol (e.g., smoke) is provided as a result of the combustion of the burning smokable material 20. As such, the tobacco rod burns back from the lit end thereof towards the opposite end (i.e., mouthend) thereof, and the smokable material of the tobacco rod is consumed by combustion during the smoking period.

The cigarette 10 also includes a filter element 30 positioned adjacent one end of the tobacco rod 15 such that the filter element and tobacco rod are axially aligned in an end-to-end relationship, preferably abutting one another. Filter element 30 has a generally cylindrical shape, and the diameter thereof is essentially equal to the diameter of the tobacco rod. The ends of the filter element are open to permit the passage of air and smoke therethrough.

The filter element includes two filter segments which are aligned in an end-to-end relationship, preferably abutting one another. A first filter segment 32 is positioned adjacent the tobacco rod; and includes a first filter material 34, such as a gathered carbon paper. The first filter material 34 is circumscribed by a wrapping material 36, such as paper plug wrap. A second filter segment 38 is positioned at the extreme mouthend of the cigarette; and includes a second filter material 40, such as gathered cellulose acetate web, plasticized cellulose acetate tow, gathered polyester web, gathered polypropylene web or polypropylene tow. The second filter material 40 is circumscribed by a wrapping material 42, such as a paper plug wrap. The second filter material 40 provides an aesthetically pleasing, white appearance. Each of the filter segments is manufactured using known filter rod making machinery. The two segments are combined using known plug tube combining techniques (e.g., using a Mulfi from Hauni-Werke Korber & Co., K.G.), and are held together using circumscribing outer wrapping material 44 (e.g., paper plug wrap) so as to form the filter element 30.

The filter element 30 is attached to the tobacco rod 15 by tipping material 45 which circumscribes both the entire length of the filter element and an adjacent region of the tobacco rod. The inner surface of the tipping material 45 is fixedly secured to the outer surface of the outer plug wrap 44 and the outer surface of the wrapping material 25 of the tobacco rod, using a suitable adhesive. A ventilated or air diluted smoking article is provided with an air dilution means, such as a series of perforations 50, each of which extend through the tipping material and plug wrap.

Referring to FIGS. 1 and 2, one type of outer wrapping material 27 has a width w (shown in FIG. 2) which is equal to the circumference of the cigarette plus the lap zone of the glue line which ultimately results during cigarette manufacture. The preferred second wrapping material 27 includes a series of perforations 60 which extend in a linear fashion along the longitudinal length of thereof. Alternatively, other configurations, such as a random perforation pattern, can be provided. The size, number and relative positioning of the individual perforations 60 can vary depending upon the desired characteristics of the cigarette which has the wrapping material incorporated therein. The individual perforations are shown as enlarged in FIGS. 1 and 2.

Referring to FIG. 1A, smokable material 20 is contained in a first circumscribing inner wrapping material 25, and a second outer wrapping material 27 circumscribes the first wrapping material. The first wrapping material 25 is formed into a circular shape such that the ends 71, 72 of the sides thereof abut one another. The ends 71, 72 of wrapping material 25 can abut one another (as shown in FIG. 1A), nearly abut one another, or slightly overlap one another. The second wrapping material 27 includes a lap zone 73 including a suitable adhesive therebetween so as to form a secure outer wrapper. As such, the width of the inner wrapping material is less than that of the outer wrapping material. A cigarette rod having such a configuration can be provided by supplying paper wrappers from two bobbins on a suitably equipped cigarette making machine, positioning the inner wrapping material on top of the outer wrapping material, passing the two wrapping materials so positioned through the garniture region of the cigarette making machine, and forming the tobacco rod. Equipment for providing a cigarette in such a manner is described in U.S. patent application Ser. No. 07/609,975 filed Nov. 6, 1990 and U.S. patent application Ser. No. 07/756,023, filed Sep. 6, 1991, which are incorporated herein by reference. Other equipment for manufacturing a cigarette in such a manner will be apparent to the skilled artisan.

Referring to FIG. 1B, smokable material 20 is contained in a first circumscribing inner wrapping material 25, and a second outer wrapping material 27 circumscribes the first wrapping material. The first wrapping material 25 is formed into a circular shape such that a lap zone 74 including a suitable adhesive therebetween is formed. The second wrapping material includes a lap zone 76 including a suitable adhesive therebetween so as to form a secure outer wrapper. A cigarette rod having such a configuration can be provided by forming a cigarette rod using known techniques, and then wrapping the rod so formed with an outer wrapping material. Equipment for providing such a cigarette will be apparent to the skilled artisan.

Another preferred embodiment of a cigarette of the present invention is shown in FIG. 3. The cigarette 10 is

generally similar to the cigarette described with reference to FIGS. 1, 1A, 1B and 2, except that the filter element 30 includes three filter segments which are aligned in an end-to-end relationship, preferably abutting one another. Such a filter element has a so-called "triple filter" configuration. Center filter segment 85, positioned between rod end filter segment 87 and mouthend segment 89, includes a filter material 91, such as gathered carbon paper. The rod end and mouthend filter segments 87, 89 each include filter material 94, 95, respectively. The filter materials 94, 95 typically are materials such as gathered cellulose acetate web, plasticized cellulose acetate tow, gathered polypropylene web, gathered polyester web, or polypropylene tow. The filter materials of each of the rod end and mouth end filter segments can be the same as or different from one another. The filter materials 94, 95 each are circumscribed by wrapping material 96, 97, respectively. The three filter segments are held together using circumscribing outer wrapping material 44 so as to form the filter element 30.

Referring to FIG. 4, there is shown a cigarette which is generally similar to that cigarette described with reference to FIG. 1, except that the tobacco rod 15 includes only one circumscribing wrapping material 27.

Referring to FIG. 5, there is shown a cigarette which is generally similar to that cigarette described with reference to FIG. 3, except that the tobacco rod 15 includes only one circumscribing wrapping material 27.

The smokable material employed in the manufacture of the tobacco rod can vary. For example, the smokable material of the cigarette can have the form of filler (e.g., tobacco cut filler). As used herein, the terms "filler" or "cut filler" are meant to include tobacco materials and other smokable materials which have a form suitable for use in the manufacture of tobacco rods for cigarettes. As such, filler can include smokable materials which are blended and are in a form ready for cigarette manufacture. The filler materials normally are employed in the form of strands or shreds as is common in conventional cigarette manufacture. For example, the cut filler material can be employed in the form of strands or shreds from sheet-like or "strip" materials which are cut into widths ranging from about 1/20 inch to about 1/60 inch, preferably from about 1/25 inch to about 1/35 inch. Generally, such strands or shreds have lengths which range from about 0.25 inch to about 3 inches.

Examples of suitable types of tobacco materials include flue-cured, Burley, Maryland or Oriental tobaccos, the rare or specialty tobaccos, and blends thereof. The tobacco material can be provided in the form of tobacco lamina; processed tobacco materials such as volume expanded or puffed tobacco, processed tobacco stems such as cut-rolled or cut puffed stems, reconstituted tobacco materials; or blends thereof. Certain reconstituted tobacco materials are described in U.S. Pat. Nos. 4,962,774 to Thomasson et al.; 4,987,906 to Young, et al. and 5,056,537 to Brown et al.; in European Patent Application No. 419,733; and in U.S. patent application Ser. Nos. 07/647,329, filed Jan. 28, 1991 and 07/710,273, filed Jun. 4, 1991 and 07/769,914, filed Sep. 30, 1991. Certain processed tobacco materials are described in U.S. Pat. Nos. 5,025,812 to Fagg, et al. and 5,065,775 to Fagg. Certain blends are described in U.S. Pat. Nos. 4,924,888 to Perfetti, et al.; 4,942,888 to Montoya, et al.; and 4,998,541 to Perfetti, et al. Preferably, the smokable material or blend of smokable materials consists essentially of tobacco filler material or consists only of tobacco filler material. Also of particular interest are smokable materials or blends of smokable materials, that when incorporated into tobacco rods which would provide mainstream smoke which would be perceived by the smoker to be harsh, woody, papery, bitter, sour, hot and irritating when smoked in cigarettes incorporating filter elements which are not filter elements of the present invention. For example, smokable filler consisting essentially of reconstituted tobacco material, consisting only of reconstituted tobacco material, incorporating relatively high levels of tobacco stems, or incorporating high levels of reconstituted and volume expanded tobacco materials can be employed in cigarettes employing the filter elements of the present invention.

Smokable materials can be cased and top dressed as is conventionally performed during various stages of cigarette manufacture. As such, the smokable material, and particularly tobacco filler material, can include casing and/or top dressing components. For example, blend components such as flavoring agents and humectants, as well as other forms of tobacco (e.g., tobacco extracts), can be applied to the smokable material, as is commonly performed when cigarettes are manufactured. See, Leffingwell, et al., *Tobacco Flavoring For Smoking Products* (1972). Suitable flavoring agents and forms of tobacco include vanillin, tobacco extracts such as tobacco essences and tobacco aroma oils, cocoa, licorice, menthol, and the like. Flavor modifying agents such as levulinic can be applied to the smokable material (e.g., in amounts ranging from about 0.01 to about 2 percent, normally from about 0.1 to about 1 percent, preferably about 0.2 to about 0.6 percent, based on the dry weight of the smokable material). Such components conveniently are applied to the smokable material as casing and top dressing components. See, U.S. Pat. No. 4,830,028 to Lawson, et al.

Typically, the tobacco rod has a length which ranges from about 35 mm to about 85 mm, preferably about 40 to about 70 mm; and a circumference of about 17 mm to about 27 mm, preferably about 22.5 mm to about 25 mm. Short cigarette rods (i.e., having lengths from about 35 mm to about 50 mm) can be employed, particularly when smokable blends having a relatively high packing density are employed.

The packing densities of the blend of smokable materials contained within the wrapping materials can vary. Typical packing densities for tobacco rods of cigarettes of the present invention range from about 150 to about 300 mg/cm^3. Normally, packing densities of the tobacco rods range from about 200 to about 280 mg/cm^3.

Exemplary tobacco rods having two layers of wrapping material circumscribing a charge of tobacco cut filler are described in Examples 1 through 32 of U.S. patent application Ser. No. 07/661,747, filed Feb. 27, 1991, and in Examples 1 through 25 of U.S. patent application Ser. No. 07/759,266, filed Sep. 13, 1991, which are incorporated herein by reference.

Typically, the filter element has a length which ranges from about 15 mm to about 40 mm, preferably about 20 mm to about 35; and a circumference of about 17 mm to about 27 mm, preferably about 22 mm to about 25 mm. The filter element can have a wide range of filtration efficiencies. Typically, the filter segment containing carbonaceous material has a low filtration efficiency for particulate matter.

For filter elements having two filter segments (e.g., as described with reference to FIGS. 1 and 4), the rod end

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filter segment typically has a length of about 20 to about 80 percent, preferably about 40 to about 60 percent, of the total length of filter element, while the mouthend filter segment typically has a length of about 20 to about 80 percent, preferably about 40 to about 60 percent, of the total length of the filter element. An exemplary filter element having two filter segments has a rod end segment of 12 mm length, and a mouth end segment of 15 mm length. For filter elements having three filter segments (e.g., as described with reference to FIGS. 3 and 5), the rod end filter segment typically has a length of about 15 to about 30 percent of the total length of the filter element, the mouthend filter segment typically has a length of about 15 to about 30 percent of the total length of the filter element, and the center filter segment typically has a length of about 30 to about 60 percent of the total length of the filter element. Carbonaceous material containing segments normally have lengths which range from about 10 mm to about 30 mm, preferably about 12 mm to about 25 mm, and more preferably about 13 mm to about 18 mm.

The carbonaceous material for the filter segment of the filter element preferably is provided within a paper. That paper most preferably is gathered; embossed and gathered; corrugated and gathered; or embossed, corrugated and gathered; to form the filter segment. Typically, for a filter element having a circumference of about 22 mm to about 25 mm, the carbon-containing paper which is gathered to form a filter segment has a width of about 3.5 inches to about 11 inches, and usually about 5 inches to about 8.5 inches. Gathered paper filter segments can be provided (i) using the apparatus described in U.S. Pat. No. 4,807,809 to Pryor, et al.; (ii) using the apparatus described in U.S. patent application Ser. No. 585,444, filed Sep. 20, 1990; (iii) using the apparatus generally as described by Keith, et al., in U.S. Pat. No. 4,283,186 at col. 4, line 50 through col. 5, line 6; or (iv) using a rod making unit available as CU-10, CU-20 or CU-20S from Decoufle s.a.r.b., together with a KDF-2 rod making apparatus from Hauni-Werke Korber & Co., K.G. Filter segments can be provided by simultaneously gathering two types of carbon-containing paper webs, or a carbon-containing paper web and another paper web (e.g., a paper available as P-144-50 ABS from Kimberly-Clark Corp. or a tobacco-containing paper web), so as to provide a segment having two types of gathered papers. Although not as desirable, filter segments can be provided by simultaneously gathering a carbon-containing paper web and a web of thermoplastic material (e.g., as described in U.S. Pat. Nos. 5,076,295 and 5,105,834 to Saintsing et al.; and in U.S. patent application Ser. Nos. 07/621,499, filed Dec. 7, 1990 and 07/868,925 filed Apr. 15, 1992), so as to provide a segment having two types of gathered webs. Carbon-containing filter segments then can be plug tube combined with one or more other filter segments (e.g., with a segment of gathered polypropylene web, gathered cellulose acetate web, gathered polyester web, or cellulose acetate tow) using known plug tube combination techniques.

The carbon-containing paper is gathered to form filter segments such that the cross-sectional void area of that segment typically ranges from about 5 to about 30 percent, generally from about 8 to about 25 percent, and often about 10 to about 20 percent. The cross-sectional void area (i.e., that area provided by passageways when the filter segment is viewed end-on) typically can be determined using an image analysis technique using an IBAS 2000 Image Analyzer available from Carl Ziess, Inc.

In one aspect, the gathered paper can be corrugated. Most preferably, the corrugations extend along the length of the carbon-containing paper which is gathered to provide the filter segment. The corrugation pattern can vary, and can have a wavy, square wave or sawtooth configuration, when viewed end-on. For example, the paper can be corrugated so as to have a wavy shape when viewed end on; such that the distance between each peak of the corrugation pattern is about 0.5 to about 2 mm, typically about 1 to about 1.5 mm; and such that the depth of the corrugation pattern is about 1 to about 2 mm. As another example, the paper can be corrugated such that the distance between each peak of the corrugation pattern is about 0.3 to about 1 mm, the depth of the corrugation pattern is about 0.2 to about 1 mm; and the corrugation pattern is such that each peak is slightly flattened, and each trough is slightly flattened.

The manner in which the carbon-containing paper is embossed or corrugated can vary. In certain circumstances it is desirable to moisten the paper prior to the time it is embossed or corrugated. For example, a carbon-containing paper web having a moisture content of about 10 weight percent can be sprayed with water or otherwise contacted with water so as to have a moisture content of about 30 to about 50 weight percent; the moistened paper then can be embossed or corrugated in the presence of applied heat (e.g., at about 120° C.); the moistened paper then can be dried convectively or using microwave drying techniques to a moisture content of about 10 weight percent; the dried, embossed or corrugated paper web then can be gathered into a continuous rod; and then the continuous rod can be divided into filter rods of the desired length.

The amount of carbonaceous material incorporated within a carbon-containing paper can vary. Typically, the amount of carbonaceous material within such paper is more than about 15, usually more than about 20, generally more than about 25, often more than about 30, and frequently, more than about 40 weight percent, based on the dry weight of the paper. Typically, the amount of carbonaceous material within such paper is less than about 65, often less than about 60 and frequently less than about 55 weight percent, based on the dry weight of the paper.

The amount of carbonaceous material within the filter segment containing the gathered paper containing that material typically ranges from about 20 to about 120 mg, often about 40 to about 110 mg, and frequently about 60 to about 100 mg.

Typically, the weight of carbon-containing paper within the filter segment incorporating that paper ranges from about 75 to about 250 mg, generally about 100 to about 225 mg and often about 125 to about 200 mg.

The carbonaceous material which is incorporated into the filter element can vary. Most preferred carbonaceous materials are highly activated. The degree of activation can vary, and typically is such so as to provide about 25 to about 125, more typically about 60 to about 70, weight percent pickup of carbon tetrachloride. Carbonaceous materials most useful herein have a high carbon content; consist primarily of carbon; and preferably have a carbon content above about 80 weight percent, and more preferably above about 90 weight percent. Preferred carbonaceous materials are

provided by carbonizing or pyrolyzing bituminous coal, tobacco material, softwood pulp, hardwood pulp, coconut hulls, kapok fibers, cotton fibers, cotton linters, and the like. Examples of suitable carbonaceous materials are activated coconut hull based carbons available from Calgon Corp. as PCB and GRC-11. Examples of suitable carbonaceous materials are coal based carbons available from Calgon Corp. as S-Sorb, BPL, CRC-11F, FCA and SGL. Examples of suitable carbonaceous materials are wood based carbons available from Westvaco as WV-B, SA-20 and BSA-20. Other carbonaceous materials are available from Calgon Corp. as HMC, ASC/GR-1 and SC II. Another carbonaceous material includes Witco Carbon No. 637. Other carbonaceous materials are described in U.S. patent application Ser. No. 07/569,325, filed Aug. 17, 1990; U.S. Pat. Nos. 4,771,795 to White, et al. and 5,027,837 to Clearman, et al.; and European Patent Application Nos. 236,922; 419,733 and 419,981. Certain carbonaceous materials can be impregnated with substances such as silver, copper, platinum, palladium, potassium bicarbonate, tobacco extracts, polyethyleneimine, manganese dioxide, chromate salts, eugenol, and 4-ketononanoic acid.

The size of the individual carbonaceous powder, particles or granules can vary, depending upon the desired design of the filter element. The individual powdered or fine grain carbonaceous particles typically have a diameter of about 10 μm to about 250 μm, often about 20 μm to about 100 μm, and frequently about 30 μm to about 70 μm. Particularly preferred powdered or fine grain particles can be characterized as having an average diameter of about 40 μm, or such that the particles or fine grains pass through a 325 U.S. mesh screen.

The carbon-containing paper includes other materials. The paper includes at least one cellulosic material, can include at least one inorganic filler, and can include other additives or ingredients employed in the paper making industry. Exemplary cellulosic materials include flax fibers, hardwood pulp (preferably unbleached), softwood pulp (preferably unbleached), cotton fibers, tobacco parts (e.g., tobacco laminae and stem pieces), and the like. Exemplary inorganic filler materials include molecular sieve particles, agglomerated calcium carbonate particles, calcium carbonate particles, calcium sulfate fibers, precipitated magnesium hydroxide gel, clay particles, and the like. Most preferably, the materials which make up the paper are incorporated into the paper during manufacture using the paper making process. Components such as sizing agents and moisture also can be incorporated into the carbon-containing paper. Typically, the amount of sizing agent incorporated into the paper is less than about 5 weight percent, and often about 0.1 to about 3 weight percent; and the moisture content of the paper ranges from about 5 to about 15 weight percent, and often about 8 to about 12 weight percent. Flavoring agents and other smoke modifying agents (e.g., tobacco extracts, heat treated tobacco extracts, spearmint, vanillin, anethole and menthol) also can be incorporated into the carbon-containing paper. Exemplary tobacco extracts are spray dried extracts and are described in U.S. Pat. No. 5,060,669 to White et al. A preferred carbon-containing paper consists essentially of softwood pulp and carbonaceous material. Certain carbon-containing papers are absent of tobacco material. Certain carbon-containing papers are absent of inorganic fillers (e.g., calcium carbonate particles), and are absent of thermoplastic fibers (e.g., polyethylene, polypropylene or polyester fibers).

The physical properties of the carbon-containing paper can vary. The thickness of the paper typically ranges from about 0.08 mm to about 0.2 mm, often about 0.13 mm to about 0.18 mm. The basis weight of the paper typically ranges from about 35 g/m^2 to about 60 g/m^2, often about 45 g/m^2 to about 55 g/m^2. The tensile strength of the paper preferably is at least about 800 g/in, typically ranges from about 1100 g/in to about 2300 g/in, although papers having greater tensile strengths can be employed. The porosity (i.e., inherent porosity) of the paper preferably is quite high, but typically ranges from about 50 to about 300 CORESTA units, often about 70 to about 200 CORESTA units. The paper can be electrostatically perforated to provide a relatively high net permeability. Typically, papers having exceedingly low porosities have a tendency to provide relatively low removal efficiencies of gas phase components of mainstream smoke.

Exemplary carbon-containing papers are available as P-144-17AC, P-144-30AC, P-144-50AC, P-144-50 HMC, P-144-50 SGL, P-144-BSHC, P-144-BAC, P-144-50-SA20, P-144-70-KCG, P-144-70-SA20, P-2674-12-12, P-2674-13-17, P-2674-14-24, P-2674-11-3, P-2674-11-7, P-3122-6-8, P-3122-6-6, P-3122-6-5, P-3122-6-12, P-3001-72-1, and P-144-BHC from Kimberly-Clark Corp. Other carbon-containing papers are described in European Patent Application No. 342,538, which is incorporated herein by reference. Other carbon-containing papers will be apparent to the skilled artisan. For example, carbon particles can be embedded in a paper substrate and employed as a filter material for a filter segment.

The filter segment provided using a gathered carbon-containing paper includes a plurality of longitudinally extending channels or passageways, and most preferably the channels or passageways, and most preferably the channels or passageways extend the total length of the filter segment. The carbon-containing paper is gathered such that aerosol particles of the mainstream smoke pass through the longitudinally extending passageways and tend to not physically interact (e.g., impact) with the carbonaceous material within the carbon-containing paper to a significant degree; while gas phase components of the mainstream smoke exhibit a tendency to interact physically and chemically with the carbonaceous material within the carbon-containing paper to a significant degree. As the air passageways or channels are formed by gathering a paper web, the individual channels of the plurality of channels are of varying shape and size. The number of channels or passageways which extend longitudinally through the carbon-containing filter segment can vary. Typically, embossed or corrugated papers which are gathered provide a greater number of longitudinally extending channels than those papers which are simply gathered. For a rod having a circumference of about 23 mm to about 25 mm which is provided by gathering a corrugated carbon-containing paper (e.g., a paper having a width of about 5.5 inches which is corrugated), the number of longitudinally extending passageways typically ranges from about 100 to about 200, often about 120 to about 180, and frequently about 130 to about 160. Typically, the area of each of such passageways when the filter segment is viewed end-on ranges from about 0.05 to about 0.3 mm^2, often about 0.06 to about 0.2 mm^2, and frequently about 0.07 to about 0.17 mm^2. For

a rod having a circumference of about 23 mm to about 25 mm which is provided by gathering a carbon-containing paper (e.g., a paper having a width of about 8.5 inches), the number of longitudinally extending passageways typically ranges from about 45 to about 100, often about 50 to about 95, and frequently about 60 to about 80. Typically, the area of each of such passageways when the filter segment is viewed end-on ranges from about 0.01 to about 0.2 mm^2, often about 0.02 to about 0.1 mm^2, and frequently about 0.03 to about 0.07 mm^2.

Preferably, the carbon-containing paper is gathered within the entire cross-sectional region of the filter segment. As such, the carbon-containing paper and air passageways provided by gathering that paper fill the entire cross-sectional region of that filter segment. In addition, the filter segment preferably is absent of any passageways of extremely large cross-sectional area. Preferably, the filter segment is absent of any air passageways having an area of more than about 1 mm^2, and most preferably is absent of any passageways having an area of more than about 2 mm^2, when the filter segment is viewed head-on.

The pressure drop of the carbon-containing filter segments of the present invention preferably is quite low. For a rod having a circumference of about 23 mm to about 25 mm, which is provided by gathering a corrugated carbon-containing paper, the pressure drop exhibited thereby typically is less than about 1, often less than about 0.5, and frequently in the range of about 0.2 to about 0.3 mm of water pressure drop at 17.5 cc/sec air flow per 1 mm length of filter segment. For a rod having a circumference of about 23 mm to about 25 mm which is provided by gathering a carbon-containing paper, the pressure drop exhibited thereby typically is less than about 2, often less than about 1.5, and frequently in the range of 0.7 to about 1.2 mm of water pressure drop at 17.5 cc/sec air flow per 1 mm length of filter segment. Typically, pressure drop values of filter rods are measured using a Filtrona Filter Test Station (CTS Series) available from Filtrona Instruments and Automation Ltd.

Typically, the tipping material circumscribes the filter element and an adjacent region of the tobacco rod such that the tipping material extends about 3 mm to about 6 mm along the length of the tobacco rod. Typically, the tipping material is a conventional paper tipping material and is adhesively secured to the filter element and the adjacent region of the tobacco rod. The tipping material can have a permeability which can vary. For example, the tipping material can be essentially air impermeable, air permeable, or be treated (e.g., by mechanical or laser perforation techniques) so as to have a region of perforations, openings or vents thereby providing a means for providing air dilution to the cigarette. The total surface area of the perforations and the positioning of the perforations along the periphery of the cigarette can be varied in order to control the performance characteristics of the cigarette.

For air diluted or ventilated cigarettes of this invention, the amount of air dilution can vary. Often, the amount of air dilution for an air diluted cigarette is greater than about 10 percent, and frequently greater than about 25 percent. The upper limit of air dilution for a cigarette typically is less than about 75 percent, more frequently less than about 65 percent.

Cigarettes of the present invention exhibit a desirably high resistance to draw. For example, cigarettes of this invention exhibit a pressure drop of between about 50 and about 200 mm water pressure drop at 17.5 cc/sec. air flow. Typically, pressure drop values of cigarettes are measured using a Filtrona Filter Test Station (CTS Series) available from Filtrona Instruments and Automation Ltd. Cigarettes of this invention preferably exhibit resistance to draw values of about 70 to about 180, more preferably about 80 to about 150 mm water pressure drop at 17.5 cc/sec. air flow.

Cigarettes of the present invention generally provide FTC "tar" yields in the range from about 2 to about 14 mg/cigarette, although other "tar" yields are possible. Typical FTC "tar" to FTC carbon monoxide ratios for such cigarettes are less than about 1.5, and sometimes are less than about 1.2. If desired, suitable catalytic compounds for the removal of carbon monoxide can be incorporated into the filter element. Cigarettes of the present invention exhibit desirable organoleptic properties. Cigarettes having carbonaceous materials within the filter element preferably exhibit a smooth smoking character, and provide less harsh and less bitter attributes than comparable cigarettes not having such a filter element. Preferred filter elements assist in reducing the gas phase components of cigarette smoke that have a propensity to provide a harsh, irritating, stingy, sour and bitter character to mainstream tobacco smoke. As such, cigarettes of the present invention are capable of providing the smoker with mainstream smoke which is smooth tasting, exhibits good strength and body, exhibits good tobacco smoke flavor, and yields an acceptable aftertaste. The filter elements of the present invention are capable of removing condensable gas phase components from mainstream tobacco smoke to a significant degree. Condensable gas phase components include organic compounds such as carbonyl compounds (e.g., acetone, formaldehyde, acrolein and acetaldehyde). Cigarettes of the present invention typically exhibit yields of certain mainstream condensable gas phase components which are less than 30 percent, frequently are less than 50 percent, and often are less than 70 percent that of those yields of a cigarette of similar format and configuration but employing a paper filter segment not incorporating the carbonaceous material used according to the present invention. Typically, certain cigarettes of the present invention, when smoked under FTC smoking conditions can provide yields of condensable gas phase components (e.g., gas phase carbonyl compounds, such as acetone, formaldehyde, acetaldehyde and acrolein) to wet total particulate matter (i.e., WTPM) of less than about 70 μg/mg, often less than about 60 μg/mg, and frequently less than 50 μg/mg.

Filter segments incorporating carbonaceous materials also can be incorporated in those types of cigarettes described in U.S. Pat. Nos. 5,027,837 to Clearman et al.; 4,714,082 to Banerjee et al.; 4,756,318 to Clearman et al.; 4,793,365 to Sensabaugh, Jr., et al.; 4,854,331 to Banerjee et al. and 4,881,556 to Clearman et al.; as well as U.S. patent application Ser. Nos. 07/882,209, filed May 13, 1992; 07/873,529, filed Apr. 21, 1992; 07/856,239, filed Mar. 25, 1992; 07/800,679, filed Nov. 27, 1991; 07/723,350, filed Jun. 28, 1991 and 07/576,751, filed Aug. 29, 1990, now U.S. Pat. No. 5,065,776; which are incorporated herein by reference.

The following examples are provided in order to further illustrate the invention but should not be construed as limiting the scope thereof. Unless otherwise noted, all parts and percentages are by weight.

EXAMPLE 1

Cigarettes substantially as shown in FIG. 1 are provided as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.7 mm. The tobacco rod has a length of about 57 mm, and the filter element has a length of about 27 mm. Each filter element includes a first 15 mm segment of gathered carbon paper and a second 12 mm segment of cellulose acetate tow. The first segment is a 8.5 inch wide carbon/tobacco paper available as P-144-BAC from Kimberly-Clark Corp., which is gathered using the apparatus described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor, et al. and circumscribed by paper plug wrap. The second segment includes triacetin plasticized cellulose acetate tow (8.0 denier per filament/40,000 total denier) circumscribed by paper plug wrap. The two segments are plug tube combined into a filter element using circumscribing paper plug wrap.

The smokable material is a blend of 17 parts flue-cured tobacco cut filler and 83 parts of another smokable filler material. The other smokable material is a cut filler material obtained by casting and drying an aqueous slurry including 5 percent sodium carboxymethylcellulose, 6 percent glycerin, and 89 percent of an agglomerated material of carbonaceous material and calcium carbonate of the type described in European Patent Application No. 419,733.

The smokable material is circumscribed by a tobacco-containing paper available as P-2249-115 from Kimberly-Clark Corp. The tobacco-containing paper is circumscribed by a paper of the type described at col. 19, lines 16-23 of European Patent Application No. 419,733.

The filter element is attached to the tobacco rod using non-porous tipping paper. The cigarette is not air diluted.

EXAMPLE 2

Cigarettes are provided as described in Example 1. However, the tobacco-containing paper inner wrap of the tobacco rod is a tobacco-containing paper available as P-2674-157 from Kimberly-Clark Corp.; and the carbon/tobacco paper of the filter element is a gathered paper containing activated coconut hull carbon and available as P-144-17AC from Kimberly-Clark Corp.

EXAMPLE 3

Cigarettes are provided as described in Example 1. However, the inner wrap of the tobacco rod is available as P-2674-157 from Kimberly-Clark Corp.; and the paper of the first filter element is a gathered carbon-containing paper available as P-144-21AC from Kimberly-Clark Corp.

EXAMPLE 4

Cigarettes are provided as described in Example 1. However, the inner wrap of the tobacco rod is available as P-2674-157 from Kimberly-Clark Corp.; and the paper of the first filter element is a gathered carbon-containing paper available as P-144-33AC from Kimberly-Clark Corp.

EXAMPLE 5

Cigarettes are provided as described in Example 1. However, the inner wrap of the tobacco rod is available as P-2674-157 from Kimberly-Clark Corp.; and the gathered paper of the first filter element is a gathered soft wood pulp/carbon paper having a thickness of about 0.005 inch available as P-144-50AC from Kimberly-Clark Corp.

EXAMPLE 6

Cigarettes substantially as shown in FIG. 1 are prepared as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm, and include a tobacco rod having a length of about 57 mm and a filter element having a length of about 27 mm. Each filter element includes a filter segment of gathered carbon-containing paper and a filter segment of cellulose acetate tow. The first filter segment has a length of about 15 mm, and includes carbon paper available as P-144-50AC from Kimberly-Clark Corp. gathered as described in Example 1. The second filter segment has a length of about 12 mm, and includes triacetin plasticized cellulose acetate tow (2.7 denier per filament/48,000 total denier). The filter material of each filter segment is circumscribed by paper plug wrap. The two filter segments are combined by a circumscribing paper plug wrap.

The smokable material is a blend of 85 parts flue-cured tobacco cut filler and 15 parts Samsun Oriental tobacco cut filler. The smokable material has a casing formula applied thereto in order that the cut filler blend has in contact therewith 0.35 percent licorice powder, 0.92 percent glycerine, 0.45 percent propylene glycol, 0.62 percent St. John's Bread (light roast) powder, 0.23 percent absolute cocoa from Robertet, Inc., 0.92 percent Fig Supreme Flavor from Bell Flavors, In., and 1.05 percent potassium carbonate. Then, the cased blend is volume expanded using the G-13 process of R. J. Reynolds Tobacco Company to provide a cased, puffed tobacco blend.

About 320 mg of the tobacco blend is circumscribed by a tobacco containing paper available as P-2831-189-B4-6606 from Kimberly-Clark Corp. The paper includes wood pulp as well as flue-cured, Burley and Basma Oriental tobacco pieces. The tobacco containing paper is in turn circumscribed by an outer paper wrap available as Reference No. 854 from Kimberly-Clark Corp. The resulting tobacco rod weighs about 0.54 g.

The filter element is attached to one end of the tobacco rod using circumscribing non-porous tipping paper. The cigarette is air diluted 33 percent by providing a ring of perforations about 13 mm from the extreme mouthend of the cigarette.

The cigarette yields 7.3 puffs when smoked under FTC smoking conditions.

EXAMPLE 7

Cigarettes are provided as described in Example 1. However, the outer wrap of the tobacco rod is available as DD-100-2 from Kimberly-Clark Corp. The inner wrap of the tobacco rod is available as P-2674-157 from Kimberly-Clark Corp., the first filter segment is a 15 mm long segment provided by gathering an 8.5 inch wide web of carbon-containing paper available as P-144-50AC from Kimberly-Clark Corp. using a rod making apparatus. the second filter segment is a 12 mm long segment of cellulose acetate tow (2.7 denier per filament/48,000 total denier), and the smokable blend is that blend described in Example 6.

EXAMPLE 8

Cigarettes substantially as shown in FIG. 4 are provided as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm. The tobacco rod has a length of about 57 mm. and the filter element has a length of about 27 mm. Each filter element includes a first 12 mm segment of gathered carbon paper and a second 15 mm segment of cellulose acetate town. The first segment is a 8.5 inch wide carbon-containing paper available as P-144-17AC from Kimberly-Clark Corp., which is gathered using the apparatus described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor et al., and circumscribed by paper plug wrap. The second segment includes triacetin plasticized cellulose acetate tow (2.7 denier per filament/48,000 total denier) circumscribed by paper plug wrap. The two segments are plug tube combined into a filter element using circumscribing paper plug wrap.

The smokable material is an American blend of tobacco cut filler which has been cased and top dressed. The smokable material is circumscribed by a paper wrap available as Reference No. 854 from Ecusta Corp.

The filter element is attached to the tobacco rod using tipping paper. The cigarette is ventilated to about 38 percent air dilution by providing a ring of 12 perforations through the tipping paper and plug wrap about 13 mm from the extreme mouthend of the cigarette.

EXAMPLE 9

Cigarettes are provided as described in Example 8. However, the carbon-containing paper within the first filter segment is available as P-144-30AC from Kimberly-Clark Corp.

EXAMPLE 10

Cigarettes are provided as described in Example 8. However, the carbon-containing paper within the first filter segment is available as P-144-50AC from Kimberly-Clark Corp.

EXAMPLE 11

Cigarettes are provided as described in Example 10. However, the second segment includes triacetin plasticized cellulose acetate tow (2.1 denier per filament/48,000 total denier), and the cigarette is ventilated to about 28 percent air dilution.

EXAMPLE 12

Cigarettes are provided as described in Example 10. However, the first segment includes a corrugated carbon-containing paper (i.e., P-144-50AC) of 5.5 inch width, and the cigarette is not ventilated. The corrugations to the carbon-containing paper have a wavy pattern when the paper is viewed end-on. The corrugation pattern is such that the distance between each peak is about 1.5 mm, and the depth of each corrugation is about 1 mm. The carbon-containing paper is treated with water to a moisture content of about 40 percent, passed through two corrugating rollers each having a wavy surface face so as to have a "tooth" and "well" configuration, convectively dried to a moisture level of about 10 percent, and gathered using rod making unit available as a CU-20 from Decoufle s.a.r.b. together with a KDF-2 rod making apparatus from Hauni-Werke Korber & Co., K.G.

EXAMPLE 13

Cigarettes are provided as described in Example 8. However, the carbon-containing paper within the first filter segment is available as P-144-50 SGL from Kimberly-Clark Corp., and the cigarette is not ventilated.

EXAMPLE 14

Cigarettes are provided as described in Example 8. However, the carbon-containing paper within the first filter segment is available as P-144-50 HMC from Kimberly-Clark Corp., and the cigarette is not air diluted.

EXAMPLE 15

Cigarettes are provided as described in Example 12. However, the cigarette is not air diluted.

EXAMPLE 16

Cigarettes are provided as described in Example 15. However, the carbon-containing paper is available as P-144-17AC from Kimberly-Clark Corp.

EXAMPLE 17

Cigarettes are provided as described in Example 15. However, the carbon-containing paper is available as P-144-30AC from Kimberly-Clark Corp.

EXAMPLE 18

Cigarettes are provided as described in Example 12. However, the second filter segment is plasticized cellulose acetate tow (2.1 denier per filament/48,000 total denier) which is manufactured using tow processing equipment to provide a 96 mm filter rod having a pressure drop of 600 mm water pressure drop at 17.5 cc/sec air flow rate. The first filter segment is provided as described in Example 12. The cigarette is ventilated to about 60 percent air dilution by providing 2 rows of perforations of 8 perforations each positioned 13 mm and 15 mm from the extreme mouthend of the cigarette.

The cigarette is smoked under FTC smoking conditions, and yields about 11.1 puffs, about 9.65 mg WTPM, about 7.93 mg "tar", about 1 mg nicotine, and about 5.68 mg carbon monoxide. The cigarette yields reduced levels of carbonyl compounds as compared to a similar cigarette not employing the gathered carbon-containing filter segment.

EXAMPLE 19

Cigarettes substantially as shown in FIG. 1 are prepared as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm, and include a tobacco rod having a length of 57 mm and a filter element having a length of about 27 mm. Each filter element includes a filter segment of gathered carbon paper and a filter segment of cellulose acetate tow. The first filter segment has a length of about 12 mm, and includes a gathered carbon-containing paper available as P-144-BHC from Kimberly-Clark Corp. circumscribed by Reference No. 646 nonporous paper plug wrap from Kimberly-Clark Corp. The carbon paper is a carbon/-tobacco paper containing about 17 percent PCB carbon of about 40 micron diameter. The first filter segment is provided by gathering an 8.5 inch width web of carbon paper as described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor, et al. The second filter segment has a length of about 15 mm, and includes triacetin plasticized cellulose acetate tow. The cellulose acetate tow is

circumscribed by nonporous paper plug wrap. The tow item is 1.2 denier per filament/48,000 total denier. Each first and second filter segment are attached together in an end-to-end relationship using a circumscribing nonporous plug wrap to provide a filter element. Each filter element is attached to each tobacco rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and about a 4 mm length of the tobacco rod in the region adjacent the filter element. The filter elements are ventilated to about 55 percent air dilution by providing a ring of mechanical perforation around the paper wrapping materials of the filter element about 13 mm from the extreme mouthend of the cigarette

The smokable blend consists of tobacco material which has been cased with a casing mixture. The tobacco material has the form of a so-called "American blend," and includes flue-cured, Burley and Oriental tobaccos as well as reconstituted tobacco from a papermaking process, and volume expanded flue-cured and Burley tobaccos. The blend of tobacco materials is cased using a mixture of glycerin, water and flavors. The blend is in the form of strands or shreds cut at about 25 cuts per inch (i.e., in cut filler form) and is equilibrated to a moisture level of about 12.5 percent. Each cigarette rod includes about 650 mg tobacco material.

The second or outer cigarette paper wrap is a 70 to 75 parts wood pulp and 25 to 30 parts calcium carbonate paper available as P-3122-40EP from Kimberly-Clark Corp. The paper wrap exhibits a net air permeability of abut 55 CORESTA units provided by electrostatic perforation, and a basis weight of about 35.5 g/m^2. The paper wrap includes about 1.3 percent ammonium alginate, about 0.4 percent Hercon 70 from Hercules Inc. and about 4.4 percent potassium citrate applied thereto, and the paper exhibits an inherent permeability (i.e., a porosity prior to electrostatic perforation) of about 1 CORESTA unit.

The first or inner cigarette paper wrap is available as P-3284-11 from Kimberly-Clark Corp. The paper wrap includes tobacco parts, wood pulp and calcium carbonate particles. The inner paper wrap is absent of added burn chemical in the form of added water soluble salt. The paper is light brown in color, has a somewhat rough surface texture, and exhibits an inherent permeability of about 50 CORESTA units.

The tobacco rod is such that the inner wrap circumscribes the smokable blend and the outer wrap circumscribes the inner wrap. The inner and outer wraps directly contact one another (i.e., the inner surface of the outer wrap contacts the outer surface of the inner wrap.)

The cigarettes are employed by burning the tobacco rod such that the blend of smokable material within the paper wrapper burns to yield smoke. When employed, such cigarettes yield very low levels of visible sidestream smoke and sustains smolder under static burning conditions after the lighting puff such that the total burnable length of the tobacco rod is consumed (i.e., the cigarette does not self-extinguish).

EXAMPLE 20

Cigarettes are provided as described in Example 19. However, the outer paper wrap of the tobacco rod is available as TOD 05504 from Ecusta Corp.; the inner wrap of the tobacco rod is available as P-2540-195 from Kimberly-Clark Corp., and the cigarette is air diluted to an air dilution level of about 50 percent.

The outer paper wrap is a heavy weight sheet, low visible sidestream paper. The base sheet contains about 15 percent calcium carbonate, about 25 percent magnesium hydroxide and about 60 percent flax fiber. The paper has an inherent permeability of about 10 CORESTA units and a basis weight of about 48 g/m^2. The paper has an aqueous solution including 2 percent malic acid and 12 percent potassium chloride incorporated therein using a size press. The paper includes about 45 mg potassium ions per gram of dry base sheet and about 1.3 percent malate ion analyzed in the paper (i.e., added to the paper as malic acid). The level of potassium ions in the paper is significantly greater than the level of sodium ions in the paper. The paper is electrostatically perforated so as to yield a net porosity of about 110 CORESTA units.

EXAMPLE 21

Cigarettes are provided as described in Example 20. However, the inner wrap of the tobacco rod is available as P-2540-194 from Kimberly-Clark Corp.; the first filter segment is provided by gathering a carbon-containing paper web 8.5 inches wide and available as P-144-BSHC from Kimberly-Clark Corp., and the second filter segment includes plasticized cellulose acetate tow (2.7 denier per filament/48,000 total denier). The cigarette is air diluted about 50 percent.

EXAMPLE 22

Cigarettes are provided as described in Example 20. However, the first filter segment is provided by gathering a carbon-containing paper web 8.5 inches wide available as P-144-50AC from Kimberly-Clark Corp.

EXAMPLE 23

A cigarette of the type generally described in U.S. patent application Ser. No. 07/882,209, filed May 13, 1992. However, the cigarette includes a mouthend piece including a 20 mm segment of triacetin-plasticized cellulose acetate tow (8.0 denier per filament/15,000 total denier) at the extreme mouthend of the cigarette, a 20 mm segment of reconstituted tobacco cut filler provided as described in U.S. patent application Ser. No. 07/710,273, filed Jun. 4, 1991, and a 10 mm segment of gathered carbon-containing paper. The paper is available as P-144-17AC from Kimberly-Clark Corp.

EXAMPLE 24

A cigarette is provided as described in Example 23. However, the gathered carbon-containing paper is available as P-144-30AC from Kimberly-Clark Corp.

EXAMPLE 25

A cigarette is provided as described in Example 23. However, the gathered carbon-containing paper is available as P-144-KGB-50 from Kimberly-Clark Corp., and is corrugated generally as described in Example 12.

What is claimed is:

1. A cigarette comprising a tobacco rod connected to a filter element having two ends and a cross-sectional area, said filter element comprising at least first and second separately formed filter segments positioned in longitudinal abutting relation, said first filter segment having a mouth end and comprising a gathered web of a paper including a carbonaceous material, the paper being gathered so as to form a plurality of longitudinal channels each having a longitudinal axis, each channel

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being open from end to end of said first filter segment along the longitudinal axis thereof, each channel further having a cross-sectional void area, the total cross-sectional void area of said open channels comprising more than about 5 percent of the cross-sectional area of the first filter segment such that at least some mainstream smoke from the tobacco rod passes through the open channels in the first filter segment, the cross-sectional area of the first filter segment being entirely filled with the carbonaceous paper material and said open channels, said second filter segment comprising a filamentary tow material abutting the mouth end of the first filter segment, said second filter segment having a draw resistance such that the cigarette has a total pressure drop of between about 50 to about 200 mm of water at 17.5 cc/sec. air

2. The cigarette of claim 1 wherein the first filter segment including the gathered web of paper including a carbonaceous material exhibits a pressure drop of less than 2 mm water pressure drop at 17.5 cc/sec air flow per 1 mm length of filter segment.

3. The cigarette of claim 1 wherein each channel has a cross-sectional void area of about 0.05 mm^2 to about 0.3 mm^2.

4. The cigarette of claim 1 wherein the filter segment is devoid of any channels having a cross-sectional void area of more than about 2 mm^2.

5. The cigarette of claim 1 wherein the filter element has a circumference of about 23 mm to about 25 mm, and the first filter segment includes about 100 to about 200 channels.

6. The cigarette of claim 1 wherein the filter element has a circumference of about 23 mm to about 25 mm, and the first filter segment includes about 45 to about 100 channels.

7. The cigarette of claim 1 wherein the paper includes more than about 20 weight percent carbonaceous material, based on the dry weight of the paper.

8. The cigarette of claim 1 wherein the paper includes more than about 30 weight percent carbonaceous material, based on the dry weight of the paper.

9. The cigarette of claim 1 or 6 wherein the paper is corrugated.

10. The cigarette of claim 1 wherein the carbonaceous material within the first filter segment is an amount of about 75 to about 250 mg.

11. The cigarette of claim 1 wherein the paper consists essentially of wood pulp and carbonaceous material.

12. The cigarette of claim 1 wherein the paper exhibits a tensile strength of at least about 800 g/in.

13. The cigarette of claim 1 wherein the paper exhibits an inherent porosity of about 50 to about 300 CORESTA units.

14. The cigarette of claim 3 or 4 wherein the filter element including the gathered web of paper including a carbonaceous material exhibits a pressure drop of less than 2 mm water pressure drop at 17.5 cc/sec air flow per 1 mm length of filter element having that paper.

15. The cigarette of claim 3 or 4 wherein the carbonaceous material within the first filter segment is an amount of about 75 mg to about 250 mg.

16. The cigarette of claim 3 or 4 wherein the paper includes more than about 30 weight percent carbonaceous material, based on the dry weight of the paper.

17. The cigarette of claim 3 or 4 wherein the carbonaceous material has a carbon content above about 90 weight percent.

18. The cigarette of claim 3 or 4 wherein the paper has a basis weight of about 35 g/m^2 to about 60 g/m^2.

19. The cigarette of claim 1, 2, 5 or 7 wherein the carbonaceous material has a carbon content about 90 weight percent.

20. The cigarette of claim 8 wherein the carbonaceous material with the paper is less than about 65 percent, based on the dry weight of the paper.

21. The cigarette of claim 1, 2, 3, 4, 5 or 7 wherein the carbonaceous material has the form of particles having a diameter of about 20 μm to about 100 μm.

22. The cigarette of claim 1, 2, 3, 4, 5 or 7 wherein the carbonaceous material has the form of particles having a diameter of about 30 μm to about 70 μm.

23. The cigarette of claim 1, 2, 3 or 4 wherein the filter element has a circumference of about 23 mm to about 25 mm, and the gathered web of paper is provided from a web having a width of about 5 inches to about 8.5 inches.

24. The cigarette of claim 1 or 2 wherein the paper has a basis weight of about 35 g/m^2 to about 60 g/m^2.

25. The cigarette of claim 1 or 3 wherein the total cross-sectional void area of the channels is about 10 to about 30 percent of the cross-sectional area of the first filter segment.

26. The cigarette of claim 1, 2 or 10 wherein the paper has a thickness of about 0.08 mm to about 0.2 mm.

27. The cigarette of claim 1, wherein the total cross-sectional void area is up to about 30 percent.

28. The cigarette of claim 1, wherein the longitudinal length of the first filter segment is 10–30 millimeters.

29. The cigarette of claim 1, wherein the web of gathered paper has a width of 3.5 to 11 inches.

* * * * *

51696 1036

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,360,023

DATED : November 1, 1994

INVENTOR(S) : Richard L. Blakley et al

It is certified that error appears in the above-indentified patent and that said Letters Patent is hereby corrected as shown below:

Col. 19, line 2, "alone" should be --along--.

Col. 19, line 16, after "air", insert --flow--.

Signed and Sealed this

Ninth Day of May, 1995

Attest:

Attesting Officer

BRUCE LEHMAN

Commissioner of Patents and Trademarks

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US005105836A

United States Patent [19]

Gentry et al.

[11] Patent Number: 5,105,836

[45] Date of Patent: Apr. 21, 1992

[54] CIGARETTE AND SMOKABLE FILLER MATERIAL THEREFOR

[75] Inventors: Jeffery S. Gentry, Pfafftown; Gary R. Shelar, Greensboro; Richard L. Lehman, Belle Mead; James L. Resce, Yadkinville; Olivia D. Furin, Winston-Salem; Stephen W. Jakob, Winston-Salem; William C. Squires, Winston-Salem, all of N.C.

[73] Assignee: R. J. Reynolds Tobacco Company, Winston-Salem, N.C.

[21] Appl. No.: 567,520

[22] Filed: Aug. 15, 1990

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 414,833, Sep. 29, 1989.

[51] Int. Cl.⁵ A24B 15/14; A24D 1/18

[52] U.S. Cl. 131/359; 131/355; 131/369

[58] Field of Search 131/359, 369, 355

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Primary Examiner—V. Millin
Attorney, Agent, or Firm—August J. Borschke

[57] ABSTRACT

A combustible smokable filler material includes an agglomerated matrix filler having an inorganic component (e.g., particles of calcium carbonate) and a carbonaceous component (e.g., calcined molasses). The smokable filler material includes a binding agent and an aerosol forming material. Tobacco extracts and/or pieces of tobacco laminae can be incorporated into the smokable filler material, and/or the smokable filler material can be blended with tobacco cut filler. Cigarettes are provided by wrapping the smokable filler material in a paper wrapping material. A typical paper wrapping material has a porosity of less than about 5 CORESTA units.

42 Claims, 1 Drawing Sheet

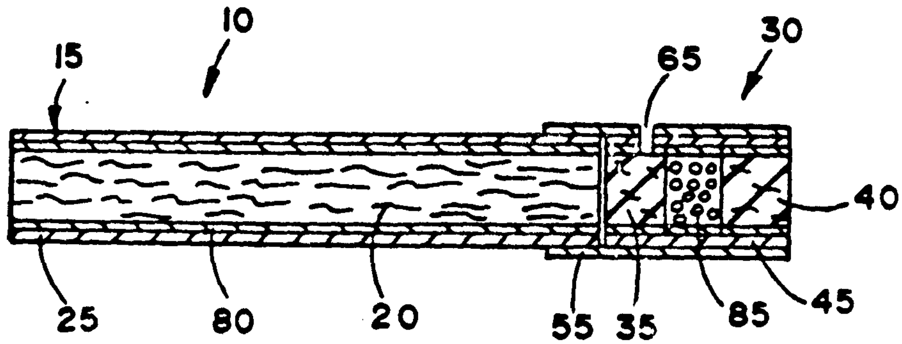

EXHIBIT NO. 13
Wit: GENTRY
Date: 5-21-97
Rptr: BB

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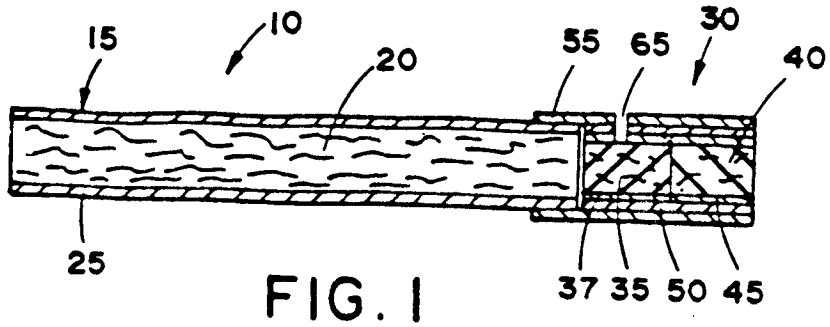

FIG. 1

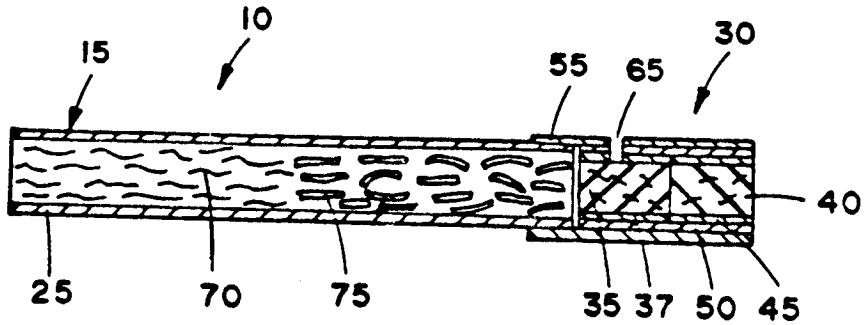

FIG. 2

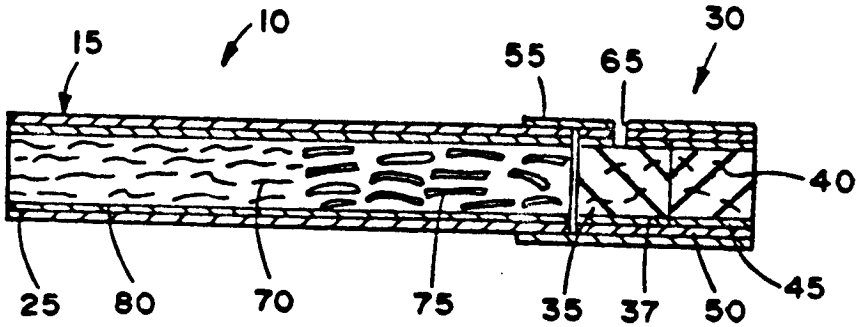

FIG. 3

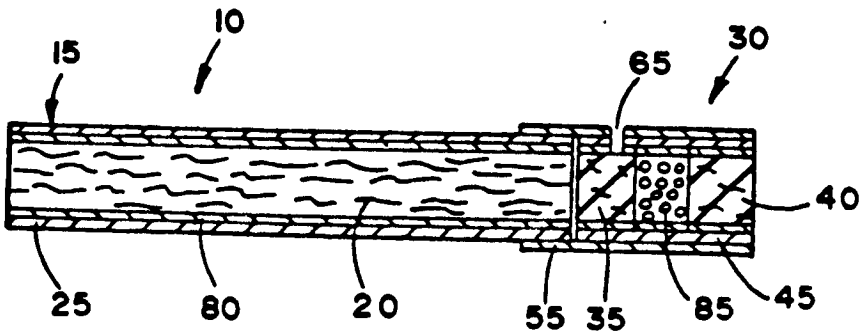

FIG. 4

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CIGARETTE AND SMOKABLE FILLER MATERIAL THEREFOR

CROSS-REFERENCE TO RELATED APPLICATION

This is a continuation-in-part of U.S. Patent application Ser. No. 414,833, filed Sep. 29, 1989, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention relates to cigarettes and other smoking articles, and in particular to cigarettes, which when smoked, yield relatively low levels of incomplete combustion products, generate low amounts of sidestream "tar" and odor, and sustain smolder during FTC smoking conditions.

Popular smoking articles, such as cigarettes, have a substantially cylindrical rod shaped structure and include a roll or charge of smokable material, such as shredded tobacco material (e.g., in cut filler form), wrapped in a paper wrapper, thereby forming a so-called "smokable rod". Normally, a cigarette has a cylindrical filter element aligned in an end-to-end relationship with the smokable rod. Typically, a filter element includes cellulose acetate tow circumscribed by plug wrap, and is attached to the smokable rod using a circumscribing tipping material.

Typically, cigarettes are employed by the smoker by lighting one end thereof and burning the smokable rod. As such, smoke normally is provided by burning smokable material, which typically is tobacco cut filler. The smoker then receives mainstream smoke (e.g., mainstream tobacco smoke) into his/her mouth by drawing on the opposite end (e.g., the filter end) of the cigarette. As such, the smoker is provided with the pleasures of smoking (e.g., smoking taste, feel, satisfaction, and the like).

During the time that the cigarette is burning, sidestream smoke is generated. Sidestream smoke is smoke which directly enters the atmosphere from the lit end of the cigarette. Sidestream smoke diffuses into the atmosphere, and the characteristic visible nature and odor thereof may be perceived negatively by some individuals. The relative amount of visible sidestream smoke generated by a burning cigarette is related to the amount of sidestream "tar" generated by that burning cigarette. Typical commercially available cigarettes which burn tobacco cut filler, and have lengths of about 84 mm (e.g., having a smokable rod length of about 57 mm and a filter element length of about 27 mm), often yield about 25 to about 35 mg of sidestream "tar" per cigarette. See, Proctor et al, Analyst, Vol. 113, p. 1509 (1988), for an apparatus and technique for determining the sidestream "tar" of a cigarette.

Numerous cigarettes which reportedly yield relatively low levels of visible sidestream smoke have been proposed. See, for example, U.S. Pat. Nos. 4,637,410 to Luke; 4,624,268 to Baker et al; 4,407,308 to Baker; 4,231,377 to Cline et al; 4,420,002 to Cline; 4,450,847 to Owens; 4,108,151 to Martin; 4,225,636 to Cline; 4,433,697 to Cline; 4,461,311 to Mathews et al; and 4,561,454 to Guess.

Through the years, there have been proposed various methods for altering the composition of mainstream tobacco smoke. For example, many tobacco substitute materials have been proposed, and a substantial listing of such materials can be found in U.S. Pat. No. 4,079,742 to Rainer et al. In addition, tobacco substitute smoking materials having the tradenames Cytrel and NSM were introduced in Europe during the 1970's.

Numerous references have proposed articles which generate flavored vapor and/or visible aerosol. Most of such articles have employed a combustible fuel source to provide an aerosol and/or to heat an aerosol forming material. See, for example, the background art cited in U.S. Pat. No. 4,714,082 to Banerjee et al.

Smoking articles which are capable of providing the pleasures associated with cigarette smoking, by heating but not necessarily burning tobacco, and without delivering considerable quantities of incomplete combustion products, are described in U.S. Pat. Nos. 4,714,082 to Banerjee et al; 4,756,318 to Clearman et al; and 4,793,365 to Sensabaugh, Jr. et al. Such smoking articles employ a combustible fuel element for heat generation; and aerosol forming substances positioned physically separate from, and in a heat exchange relationship with, the fuel element. During use, heat generated by the fuel element acts to volatilize the aerosol forming substances, thereby providing an aerosol which resembles tobacco smoke. Such smoking articles yield extremely low levels of visible sidestream smoke as well as low levels of FTC "tar".

It would be desirable to provide a good tasting cigarette which provides good smoking satisfaction, provides relatively low mainstream gas phase yields, provides relatively low levels of incomplete combustion products, sustains smolder during FTC smoking conditions, yields an ash having desirable physical characteristics, and generates low levels of sidestream "tar" and hence the low levels of visible sidestream smoke.

SUMMARY OF THE INVENTION

The present invention relates to smoking articles incorporating tobacco in cut filler form and/or in a processed form. Preferred smoking articles have the form of a cigarette having two essential components: (i) a roll or charge of smokable material, and (ii) an outer wrapping material (e.g., a paper wrapper) circumscribing the roll of smokable material. Cigarettes of the present invention incorporate a smokable filler material (described in greater detail hereinafter) as at least a portion of the smokable material thereof.

The preferred wrapping material, which surrounds the roll of smokable material to thereby form a "smokable rod", is a low air permeability cigarette paper wrapper. Highly preferred wrappers having a low air permeability or low porosity exhibit a porosity below about 5 CORESTA units. A CORESTA unit is a measure of the linear air velocity which passes through a 1 cm^2 area of wrapper at a constant pressure of 1 centibar. See CORESTA Publication ISO/TC 126/SC I N159E (1986).

One form of smokable material is a tobacco-containing smokable filler material. Such a smokable material of the present invention comprises an intimate mixture of (i) tobacco (e.g., shredded tobacco laminae milled tobacco laminae, pieces of tobacco stems, tobacco fines, tobacco dust, or a tobacco extract or other form of processed tobacco), and (ii) an agglomerated matrix filler. The agglomerated matrix filler has, in intimate contact, a carbonaceous component and an inorganic component. Preferably, the agglomerated matrix filler is provided in particulate form. The smokable filler material includes a binding agent in intimate contact

with the agglomerated matrix filler and tobacco. As such, the binding agent acts to maintain particles of the tobacco and agglomerated matrix filler together to form the smokable filler material. Such a tobacco-containing smokable filler material also can include certain flavoring agents (e.g., cocoa, licorice, organic acids, menthol, and the like) and/or aerosol forming material (e.g., glycerin, propylene glycol, and the like) in intimate contact therewith. The tobacco-containing smokable filler material can be cast as a sheet from an aqueous slurry, provided as a sheet using a paper-making process, or provided in extruded form. Such a tobacco-containing smokable filler material can be employed individually as the sole smokable material of the cigarette, or that tobacco-containing smokable filler material can be physically mixed with (i.e., blended) or otherwise employed with other smokable materials, such as tobacco cut filler.

Another form of smokable filler material of the present invention comprises an agglomerated matrix filler. The agglomerated matrix filler has, in intimate contact, a carbonaceous component and an inorganic component. Preferably, the agglomerated matrix filler is provided in particulate form. The smokable filler material includes a binding agent in intimate contact with the agglomerated matrix filler. As such, the binding agent acts to maintain particles of agglomerated matrix filler together to form the smokable filler material. Such a smokable filler material also can include certain flavoring agents and/or aerosol forming materials in intimate contact therewith. The smokable filler material can be cast as a sheet from an aqueous slurry, provided as a sheet using a paper-making process, or provided in extruded form. Such a smokable filler material can be physically mixed with or otherwise employed with tobacco-containing smokable materials and/or tobacco cut filler.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 through 4 are longitudinal sectional views of smoking articles of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of a cigarette and smokable filler material of the present invention is shown in FIG. 1. The cigarette 10 includes a generally cylindrical rod 15. The rod includes a roll of smokable material 20 wrapped in at least one layer of circumscribing outer wrapping material 25 (e.g., paper). The rod 15 is hereinafter referred to as a "smokable rod". The ends of the smokable rod 15 are open to expose the smokable material which is to be burned. The smokable rod is used by lighting one end thereof, and aerosol (e.g., smoke) is provided as a result of the combustion of the burning smokable material. As such, the smokable rod burns from the lit end thereof towards the opposite end thereof.

The cigarette 10 also includes a filter element 30 positioned adjacent one end of the smokable rod 15 such that the filter element and smokable rod are axially aligned in an end-to-end relationship, preferably abutting one another. Filter element 30 has a generally cylindrical shape, and the diameter thereof is essentially equal to the diameter of the smokable rod. The ends of the filter element are open to permit the passage of air and smoke therethrough. The preferred filter element has at least two filter segments. As shown in FIG. 1, a first filter segment is positioned adjacent the smokable rod, and preferably includes a carbonaceous filter material 35 circumscribed by a wrapping material 37; while a second filter segment is positioned at the extreme mouthend of the cigarette, and preferably includes a filter material 40, such as a gathered non-woven polypropylene web or cellulose acetate tow, circumscribed by a wrapping material 45. The filter material 40 of the segment preferably is a material which provides an aesthetically pleasing, white appearance. Each of the filter segments is manufactured using known filter rod making machinery. The two segments are combined using known plug tube combining techniques, and are held together using circumscribing wrap 50 so as to form the filter element.

The filter element 30 normally is attached to the smokable rod 15 by tipping material 55, which circumscribes both the entire length of the filter element and an adjacent region of the smokable rod. The inner surface of the tipping material 55 is fixedly secured to the outer surface of the plug wrap 50 and the outer surface of the wrapping material 25 of the smokable rod, using a suitable adhesive. The cigarette 10 can be manufactured using known cigarette making techniques and equipment. Optionally, a ventilated or air diluted cigarette is provided with an air dilution means such as a series of perforations 65 which extend through the tipping material 55, plug wrap 50 and wrapping material 37. Such ventilation can be provided to the cigarette using known techniques, such as laser perforation techniques.

Another preferred embodiment of a cigarette and smokable filler material of the present invention is shown in FIG. 2. The cigarette 10 is generally similar to the cigarette described with reference to FIG. 1, except that the smokable material has the form of a blend which is provided in a segmented fashion. At one end of the smokable rod 15 (i.e., at the end of the cigarette to be lit) is located a first segment 70 of smokable material. At the other end of the smokable rod 15 (i.e., at the end of the smokable rod adjacent the filter element) is located a second segment 75 of smokable material. Each segment is defined or identified in terms of its composition (i.e., the composition of each segment is different). The segments are aligned in an abutting end-to-end relationship; however, there can be a certain amount of intermixing of smokable materials in the region where the two segments meet. The length which each segment of smokable material extends along the smokable rod can vary. However, the relative longitudinal length of the first segment relative to the second segment normally ranges from about 1:2 to about 2:1, with about 1:1 being preferred. Such smokable rods can be manufactured using apparatus described in U.S. Pat. Nos. 4,009,722 to Wahle et al and 4,516,585 to Pinkham.

For preferred cigarettes of the type shown in FIG. 2, the first segment 70 normally includes tobacco in some type of smokable form. Such a form of tobacco includes tobacco cut filler (e.g., tobacco laminae, processed tobacco materials, volume expanded tobacco filler, reconstituted tobacco filler materials, and the like, and blends thereof), and blends thereof with other smokable materials. Examples of processed tobacco materials are deproteinated reconstituted tobacco materials described in U.S. Pat. Nos. 4,887,618 to Bernasek et al and 4,941,484 to Clapp et al, which are incorporated herein by reference. Another example of a processed tobacco material is a tobacco material processed according to the methods set forth in U.S. Patent application Ser. No. 484,587,

now U.S. Pat. No. 5,065,775 to Fagg filed Feb. 23, 1990, which is incorporated herein by reference. Preferred cigarettes also have a second segment 75 which includes a smokable material or blend of smokable materials different in overall composition from the overall composition of the smokable material(s) of the first segment 70. The first segment 70 and/or the second segment 75 include at least one smokable filler material of the present invention.

Another preferred embodiment of a cigarette of the present invention is shown in FIG. 3. The cigarette 10 is generally similar to the cigarette described with reference to FIGS. 1 and 2, except that the smokable material 20, which incorporates smokable filler material of the present invention, is wrapped or contained in a processed tobacco sheet 80, or other inner wrapper material. The processed tobacco sheet 80 normally is a reconstituted tobacco sheet which is manufactured using a paper-making process, and a single layer of the sheet circumscribes the smokable material. The smokable material wrapped in the processed tobacco sheet 80 is in turn wrapped in a single layer of circumscribing outer wrapping material 25 (e.g., cigarette paper).

Another preferred embodiment of a cigarette of the present invention is shown in FIG. 4. The cigarette 10 is generally similar to the cigarette described with reference to FIGS. 1, 2 and 3, except that the filter element includes three segments. Segment 85, positioned between first filter material 35 and filter material 40, preferably is composed of a particulate matter such as activated carbon granules, magnesium silicate granules, silica gel particles, or the like.

The smokable material employed in the manufacture of the smokable rod can vary, and most preferably has the form of cut filler. As used herein, the term "cut filler" in referring to smokable materials is meant to include smokable materials which have a form suitable for use in the manufacture of smokable rods for cigarettes. As such, cut filler can include smokable materials which are blended and are in a form ready for cigarette manufacture. Smokable materials normally are employed in the form of strands or shreds as is common in cigarette manufacture. For example, cut filler can be employed in the form of strands or shreds cut from sheet-like or "strip" materials. Such strip materials are cut into widths ranging from about 1/5 inch to about 1/60 inch, preferably from about 1/25 inch to about 1/35 inch. Generally, the resulting strands or shreds have lengths which range from about 0.25 inch to about 3 inches. Cut filler also can have an extruded form (e.g., extruded strands), or other physically processed form.

The smokable rods of cigarettes of the present invention include smokable filler material of the present invention. The smokable filler material can be employed in a cut filler form.

One preferred type of smokable filler material of the present invention comprises an agglomerated matrix filler including an agglomerated matrix of a carbonaceous component and an inorganic component in intimate contact. The agglomerated matrix filler is in turn intimately mixed with a binding agent to provide the smokable filler material. Such a smokable filler material most preferably includes as part of the ultimate mixture, at least one aerosol forming material and/or at least one flavoring agent. If desired, other agents, which have the ability to alter the composition of the aerosol generated by the smokable filler material, can be incorporated into that smokable filler material. The agglomerated matrix filler normally includes about 80 to about 97, preferably about 90 to about 97 weight percent inorganic component, and about 3 to about 20, preferably about 3 to about 10 weight percent carbon provided by the carbonaceous component. Such a smokable filler material normally includes about 60 to about 95, preferably about 65 to about 90 weight percent agglomerated matrix filler; up to about 20, preferably about 2 to about 10 weight percent binding agent; up to about 20, preferably about 3 to about 10 weight percent aerosol forming material; and sufficient amounts of flavoring agent to provide the desired flavor characteristics. If desired, a further carbonaceous material (e.g., pyrolyzed alpha cellulose) can be incorporated into the smokable filler material, usually in amounts of up to about 10, and sometimes up to about 30 weight percent, based on the total dry weight of the smokable filler material. However, such further carbonaceous material is not a necessary component of the smokable filler material, and the smokable filler material can be absent of such carbonaceous material. The smokable filler material is combustible, and is normally employed with (e.g., blended with) another smokable material (e.g., tobacco cut filler) in order to provide a cigarette of the present invention.

One preferred type of tobacco-containing smokable filler material of the present invention comprises an agglomerated matrix filler including an agglomerated matrix of a carbonaceous component and an inorganic component in intimate contact. The agglomerated matrix filler is in turn intimately mixed with some form of tobacco and binding agent to provide the smokable filler material. Such a tobacco-containing smokable filler material preferably includes as part of the ultimate mixture, at least one aerosol forming material and/or at least one flavoring agent. If desired, other agents, which have the ability to alter the composition of the aerosol generated by the smokable filler material, can be incorporated into that smokable filler material. The agglomerated matrix filler normally includes about 80 to about 97, preferably about 90 to about 97 weight percent inorganic component, and about 3 to about 20, preferably about 3 to about 10 weight percent carbon provided by the carbonaceous component. Such a tobacco-containing smokable filler material normally includes up to about 50, typically up to about 20 weight percent of some form of tobacco; about 45 to about 90, preferably about 50 to about 85 weight percent agglomerated matrix filler; up to about 20, preferably about 2 to about 10 weight percent binding agent; up to about 20, preferably about 3 to about 15 weight percent aerosol forming material; and sufficient amounts of flavoring agent to provide desired flavor characteristics. If desired, a further carbonaceous material (e.g., pyrolyzed alpha cellulose) can be incorporated into the smokable filler material, usually in amounts of up to about 10, and sometimes up to about 30 weight percent, based on the total dry weight of the smokable filler material. However, such further carbonaceous material is not a necessary component of the smokable filler material, and the smokable filler material can be absent of such carbonaceous material. The smokable filler material is combustible and can be employed individually as the sole smokable material of a cigarette of the present invention.

Another preferred type of smokable filler material of the present invention comprises agglomerated matrix filler including an agglomerated matrix of a carbonaceous component and an inorganic component. The

agglomerate matrix filler is intimately mixed with a binding agent and at least one aerosol forming material to provide a smokable filler material. Such a smokable filler material most preferably includes as part of the ultimate mixture, at least one flavoring agent and some form of tobacco. The agglomerated matrix filler normally includes about 80 to about 97, preferably about 90 to about 97 weight percent inorganic component and about 3 to about 20, preferably about 3 to about 10 weight percent carbon provided by the carbonaceous component. Such a smokable filler material normally includes up to about 20, preferably about 3 to about 15 weight percent binding agent; greater than about 20, preferably about 25 to about 80, more preferably about 30 to about 50 weight percent aerosol forming material; and less than about 80, preferably about 30 to about 70 weight percent filler component including the previously described agglomerated matrix filler. In particular, the filler component can include (i) all of the previously described agglomerated matrix filler, or (ii) a blend of the previously described agglomerated matrix filler with an inorganic filler material (e.g., precipitated calcium carbonate) and/or an organic filler material (e.g., tobacco). Amounts of flavoring agent sufficient to provide the desired flavor characteristics to the smokable filler material can be incorporated into that material. If desired, a further carbonaceous material (e.g., pyrolyzed alpha cellulose) can be incorporated into the smokable filler material, usually in amounts of up to about 10, and sometimes up to about 30 weight percent, based on the total dry weight of the smokable filler material. However, such further carbonaceous material is not a necessary component of the smokable filler material, and the filler smokable material can be absent of such carbonaceous material. The smokable filler material is combustible and can be blended with other smokable materials.

The tobacco-containing smokable filler materials of the present invention have some form of tobacco incorporated therein during manufacture. The tobacco which is employed to provide such a tobacco-containing smokable filler material can have a variety of forms, including tobacco extracts, milled tobacco laminae, tobacco fines or dust, shredded or comminuted tobacco laminae, tobacco stems, volume expanded tobacco filler and other forms of processed tobacco, and the like, and combinations thereof. Tobacco extracts are processed forms of tobacco and are provided by extracting a tobacco material using a solvent such as water, carbon dioxide, a hydrocarbon, or a halocarbon, as well as various other organic and inorganic solvents. Tobacco extracts can include spray dried extracts; freeze dried extracts; heat treated extracts, such as those extracts described in U.S Patent application Ser. Nos. 511,158, filed Apr. 19, 1990 and 452,175, now U.S. Pat. No. 5,060,699 to White, et al., filed Dec. 18, 1989; tobacco essences, such as those essences described in European Patent Application No. 326,370; and aroma oils and extracts described in U.S. Pat. No. 4,506,682 to Mueller and U.S. Patent application Ser. No. 310,413, filed Feb. 13, 1989.

The smokable filler materials of the present invention incorporate a binding agent. Examples of suitable binding agents include hydroxypropylcellulose such as Klucel H from Aqualon Co.; hydroxypropylmethylcellulose such as Methocel K4MS from The Dow Chemical Co.; hydroxyethylcellulose such as Natrosol 250 MRCS from Aqualon Co.; microcrystalline cellulose such as Avicel from FMC; methylcellulose such as Methocel A4M from The Dow Chemical Co.; and sodium carboxymethylcellulose such as CMC 7HF and CMC 7H4F from Hercules Inc. Especially preferred binding agents include the alginates, such as ammonium alginate, sodium alginate, propylene glycol alginate and potassium alginate. The alginates, and particularly the high viscosity alginates, can be employed in conjunction with controlled levels of free calcium ions. Other binding agents include starches (e.g., corn starch), guar gum, locust bean gum, pectins and xanthan gum. Combinations or blends of binding agents (e.g., a mixture of guar gum and locust bean gum) can be employed.

The smokable filler materials of the present invention can have at least one aerosol forming material and/or at least one flavoring agent incorporated therein. The preferred aerosol forming materials include polyhydric alcohols (e.g., glycerin, propylene glycol or triethylene glycol), any other materials which yield a visible aerosol, or mixtures thereof. The aerosol forming material can be provided as a portion of the binding agent (e.g., when the binding agent is propylene glycol alginate). Combinations of aerosol forming materials can be employed. The flavoring agents can vary, and include menthol, vanillin, citric acid, malic acid, cocoa, licorice, and the like, as well as combinations thereof. See, Leffingwell et al, *Tobacco Flavoring for Smoking Products* (1972).

It is sometimes desirable to incorporate a caramelizing material into the smokable filler materials of the present invention. Caramelizing materials can act to improve (i) the integrity of the ash and fire cone of the cigarette, (ii) the appearance of the smokable filler material, and (iii) the flavor characteristics of the mainstream smoke of the cigarette. The caramelizing material can be incorporated into the smokable filler material during the preparation of that material and/or applied to the surface of that material (e.g., as a powder) after the manufacture thereof. Normally, the amount of caramelizing material which is employed to treat a particular smokable filler material is such that the resulting material which incorporates the caramelizing material includes up to about 20 weight parts, typically up to about 5 weight parts, of caramelizing material and greater than about 80 weight parts of the smokable material which is treated. Examples of suitable caramelizing materials include sugars, such as glucose, fructose and sucrose; and compositions such as Carob Powder Code 1739 from M. F. Neal, Inc.

The smokable filler materials of the present invention can be surface treated with certain substances. For example, the smokable filler materials can have powdered substances applied to the surface thereof. Exemplary substances include cocoa powder, licorice powder, powdered inorganic materials (e.g., potassium carbonate or iron oxide), tobacco dust, finely divided tobacco laminae, or the like, or blends thereof. The surface treatment of the smokable filler materials can provide to those materials improved color and appearance, improved ash characteristics, and improved flavor characteristics.

The previously described agglomerated matrix filler has the form of an agglomerated matrix of an inorganic component and a carbonaceous component. The inorganic component can include particles of calcium carbonate, calcium sulfate, magnesium oxide, and the like. A particularly preferred agglomerated matrix filler is agglomerated calcium carbonate, and most preferably,

agglomerated precipitated calcium carbonate. Such an agglomerated matrix filler can be prepared by providing an aqueous slurry of calcium carbonate particles and a binding material, and drying the slurry to form an agglomerated matrix of calcium carbonate (i.e., a matrix of a plurality of calcium carbonate particles spaced within a continuous or semi-continuous phase of binding material). If desired, the slurry can be volume expanded by incorporating a foaming agent therein. Examples of suitable foaming agents include linear sodium benzene sulfonates, linear alkyl sulfonates and linear alkyl ethoxy sulfates. Calcium carbonate particles which are employed to provide the agglomerated matrix typically exhibit a surface area of less than about 20 m^2/g, frequently less than about 10 m^2/g, and sometimes less than about 1 m^2/g, as determined using the Brunauer, Emmett and Teller (BET) method described in *J. Am. Chem. Soc.*, Vol. 60, p. 309 (1938). Typical binding materials are organic materials, such as cellulosic derivatives (e.g., sodium carboxymethylcellulose), and preferably are sugar containing materials, such as molasses, high fructose corn syrup, or Carob Powder Code 1739 from M. F. Neal, Inc. Other organic materials, such as pectins and alginates, also can be employed.

Preferably, a high solids content aqueous slurry (e.g., about 40 to about 55 weight percent solids content slurry) of calcium carbonate and binding material is spray dried to provide agglomerated particles (e.g., normally spherical particles) of calcium carbonate particles and binding material. Alternatively, the slurry can be dried by the application of heat to provide a solid mass of agglomerated calcium carbonate and binding material, and the solid mass can be ground to yield particles of the desired size. Preferably, the amount of calcium carbonate relative to binding material ranges from about 20:1 to about 2:1, more preferably about 15:1 to about 4:1, on a dry weight basis. Normally, the inorganic particles agglomerated using saccharide and polysaccharide materials tend to lose their agglomerated character when contacted with water under ambient conditions, as a result of the propensity of the saccharide and polysaccharide materials to be soluble in water.

The agglomerated matrix of inorganic component and organic binding material is subjected to heat treatment. As such, volatile components from the organic binding material are expelled, and the organic binding material is calcined to form an essentially water insoluble, clean burning carbonaceous component. Normally, the heat treatment of the agglomerated matrix filler is provided under controlled atmosphere, in order to minimize or prevent oxidation of the binding material. Preferably, the heat treatment provides a binding material which is in the form of a carbonaceous material, and in turn, provides a means for agglomerating the particles of inorganic component into a matrix form. In particular, the particles of agglomerated calcium carbonate and binding material can be heat-treated (e.g., to a temperature of up to about 625° C., and usually up to about 600° C.) using an oven, batch furnace, a fluidized bed, rotary calciner, belt calciner, or the like. For example, particles of spray dried calcium carbonate particles agglomerated using molasses can be heated in a fluidized bed having gaseous nitrogen flowing therethrough, heated at temperatures sufficient to heat the particles from about 300° C. to about 625° C., and collected. The agglomerated matrix of inorganic component and organic binding material can be subjected to heat treatment sufficient to calcine the organic binding material by subjecting the agglomerated matrix to very high temperatures (e.g., up to about 900° C.) for a short time period and under conditions sufficient to avoid decomposition of the inorganic component (e.g., when the inorganic component is calcium carbonate). However, if the inorganic component is calcium carbonate, and the calcium carbonate undergoes some decomposition during the calcining step, the agglomerated material can be re-carbonated by (i) exposing that material to carbon dioxide atmosphere, or (ii) dispersing that material in water and bubbling carbon dioxide into the dispersion.

After the calcining process, the agglomerated calcium carbonate particles normally have a calcium carbonate content of greater than about 80, frequently greater than about 90 weight percent and a carbon content provided by the carbonaceous component of greater than about 3 weight percent. Normally, the resulting agglomerated particles are screened to sizes of about −50/+325 US Mesh, and often about −80/+200 US Mesh. Preferred agglomerated calcium carbonate particles which have been calcined are essentially insoluble in water, are spherical in shape, are free flowing, and exhibit a bulk density of about 0.1 g/cm^3 to about 1.1 g/cm^3, frequently about 0.3 g/cm^3 to about 1 g/cm^3, using mercury intrusion techniques. As such, calcined agglomerated calcium carbonate particles provide an inorganic material having a bulk density less than about 2 g/cm^3, and preferably less than about 1 g/cm^3, which includes an inorganic component having a bulk density greater than about 2.5 g/cm^3. Normally, such calcined agglomerated calcium carbonate particles exhibit a surface area of less than about 30 m^2/g, and often about 10 m^2/g to about 25 m^2/g, as determined using the BET method.

If desired, the bulk density of the calcined agglomerated inorganic filler can be lowered by digesting away part of the inorganic component with an acidulant. For example, calcined agglomerated can be dispersed in water, and an aqueous hydrochloric acid solution can be added to the resulting slurry which is agitated. The acid reacts with the calcium carbonate, and essentially does not react with the carbonaceous component. Thus, the carbonaceous component acts to hold together the remaining calcium carbonate, while a portion of the calcium carbonate reacts to produce carbon dioxide gas and water soluble calcium chloride.

Other inorganic materials can be incorporated as fillers in the smokable filler materials of the present invention. Such inorganic materials often have a fibrous, flake, crystalline, hollow, amorphous or particulate form. Examples of inorganic materials include calcium carbonate, calcium sulfate particles, magnesium oxide, magnesium hydroxide, perlite, synthetic mica, vermiculite, clays, thermally stable carbon fibers, zinc oxide, dawsonite, low density hollow spheres of calcium carbonate, glass spheres, glass bubbles, sodium silicate, thermally stable carbon microspheres, calcium sulfate fibers, hollow ceramic microspheres, alumina, calcium carbonate agglomerated using an organic material, low density processed calcium carbonate, and the like. If desired, organic materials (e.g., grains) can be incorporated as fillers into smokable filler materials of the present invention. Such inorganic and organic fillers are employed to occupy space in the smokable filler materials of the present invention.

Calcium carbonate agglomerated using ammonium alginate is an example of an agglomerated matrix filler having an inorganic component in an organic compo-

nent. Other inorganic components include calcium sulfate, magnesium oxide and magnesium carbonate. Such an agglomerated matrix filler is provided by preparing an aqueous slurry of calcium carbonate particles and hydrated algmate, and drying the slurry to form an agglomerated matrix of calcium carbonate (i.e., a matrix of a plurality of calcium carbonate particles spaced within a continuous or semi-continuous phase of alginate). If desired, the slurry can be volume expanded by incorporating a foaming agent therein. Examples of suitable foaming agents include linear sodium benzene sulfonates, linear alkyl sulfonates and linear alkyl ethoxy sulfates. Preferably, a high solids content aqueous slurry of calcium carbonate and alginate is spray dried to provide agglomerated particles (e.g., normally spherical particles) of calcium carbonate particles and alginate. Alternatively, the slurry can be dried by the application of heat to provide a solid mass of agglomerated calcium carbonate and alginate, and the solid mass can be ground to yield particles of the desired size. Preferably, the amount of calcium carbonate relative to alginate ranges from about 99:1 to about 10:1, on a dry weight basis. Typically, the particles of calcium carbonate agglomerated using alginate are essentially insoluble in water under ambient conditions. In particular, the essentially water insoluble character of the alginate in the agglomerated matrix filler tends to limit to a great degree any propensity of the agglomerated matrix filler to lose its agglomerated character when contacted with water under ambient conditions. The agglomerated matrix filler is rendered insoluble due to the interaction of the alginate with calcium ions of the calcium carbonate. If desired, the agglomerated matrix filler can be treated with a dilute solution of acid to decompose a portion of the calcium carbonate and liberate calcium ions and the resulting calcium ions can act to render insoluble the alginate component of the agglomerated matrix filler.

The agglomerated matrix filler having an inorganic component and an organic component can incorporate a variety of other organic components. For example, the organic component can be pectin, which has a tendency to become essentially water insoluble upon interaction with calcium. Alternatively, agglomerated matrix filler having a polysaccharide organic component can be treated with divalent ions (e.g., calcium, barium, cobalt, iron or manganese ions) or trivalent ions (e.g., iron or aluminum ions) to render the polysaccharide essentially water insoluble. As yet another example, a slurry of polysaccharide material (e.g., ethylcellulose) and inorganic component particles can be provided in a non-aqueous solvent (e.g., alcohol) and dried, resulting in the formation of an agglomerated matrix filler which is essentially water insoluble.

Another type of inorganic material which can be incorporated into smokable filler materials of the present invention is a low density inorganic filler. Such a filler is provided by providing particles of a calcium salt, decomposing the anion of the salt and contacting the particles with carbon dioxide. Examples of suitable salts include calcium propionate, succinate, tartrate, stearate, salicylate, palmitate, oleate, lactate, gluconate, citrate, ascorbate, acetylsalicylate and benzoate. Other suitable salts include calcium salts of saccharides and polysaccharides. Such salts are subjected to conditions sufficient to decompose the anion thereof, which usually involves subjecting the salt to heat treatment under carbon dioxide atmosphere.

One method for providing a low density inorganic filler involves heating calcium lactate particles screened to −80/−170 US Mesh at about 600° C. for about 8 hours under a steady 228 ml/min. flow of carbon dioxide gas, so as to provide a material which has undergone about a 65 percent weight loss. About 20 weight parts of the material is charged into about 80 weight parts water, and the resulting slurry is contacted with sufficient hydrochloric acid solution to lower the pH thereof to about 6.8. The material then is removed from the water, washed with water, dried, and screened to a particle size of −80/+170 US Mesh. Such material is greater than about 95 weight percent calcium carbonate, and exhibits a bulk density of about 0.4 g/cm^3, as determined using mercury intrusion techniques.

Typically, the smokable filler materials of the present invention are provided by forming an aqueous slurry of binding agent and the other components of that smokable filler material, casting the slurry as a sheet, and drying the cast material to form a relatively dry, workable sheet. Techniques and equipment for casting a slurry as a sheet will be apparent to the skilled artisan. Other materials, such as calcium acetate, potassium carbonate, pH control agents, urea, amino acids, potassium chloride and/or calcium hydroxide, can be incorporated into the slurry. Sequestering agents (e.g., diammonium hydrogen orthophosphate, potassium hexametaphosphate, sodium citrate or tetrasodium pyrophosphate) can be incorporated into the slurry in amounts sufficient to control the free calcium ion concentration in the slurry. The cast material can be dried at ambient temperatures or at elevated temperatures. Further, an aqueous solution of calcium salts can be applied to the cast slurry. The resulting dried sheet can be cut or broken into "strip" form, and later can be cut or shredded into cut filler form.

The smokable filler materials of the present invention can be provided using a paper-making process. In particular, an aqueous slurry of a cellulosic material (e.g., softwood pulp, hardwood pulp, flax fibers and/or shredded tobacco stems) and the previously described filler can be cast as a mat on a fibrous belt or wire screen, and dried to the desired moisture level. Normally, a slurry, dispersion or solution of flavoring agents, tobacco extracts, tobacco parts, aerosol forming materials, and the like, can be applied to the mat (e.g., as a spray), and the resulting mat can be dried further to form a sheet. The resulting dried sheet can be cut or broken in "strip" form, and later can be cut or shredded into cut filler form. Techniques and equipment for making a paper-type sheet will be apparent to the skilled artisan.

The smokable filler materials of the present invention can be extruded into the desired shape using suitable extrusion techniques. See, for example, the types of processes described in U.S. Pat. No. 4,880,018 to Graves, Jr. et al, which is incorporated herein by reference. Alternatively, an aqueous slurry of the components of the smokable material and an alginate binding agent can be extruded into an aqueous solution of calcium ions (e.g., an aqueous solution of calcium chloride), collected and dried. If desired, extruded smokable filler materials can be physically processed (e.g., subjected to treatment using rollers, etc.) and formed into the desired shape.

The smokable rods of cigarettes of the present invention often include a physical mixture or blend of smokable materials. The blend can include two or more

smokable filler materials of the present invention, or a physical mixture of at least one smokable filler material of the present invention with at least one other smokable material. Certain preferred cigarettes include within such a blend, a sufficient amount of at least one of the smokable filler materials of the present invention such that the smokable material within each cigarette comprises at least about 1 percent of the carbonaceous material, based on the total weight of the blend. In particular, cigarettes having such types of smokable filler materials and having low porosity paper outer wrappers (e.g., having outer wrappers having less than about 5 CORESTA units) have the propensity to sustain smolder (e.g., not self-extinguish), when smoked under FTC smoking conditions. FTC smoking conditions consist of 35 ml puffs of 2 second duration, taken every 60 seconds.

The smokable filler materials of the present invention can be blended with tobacco cut filler. The type of tobacco can vary, and can include flue-cured, Burley, Maryland and Oriental tobaccos, as well as the rare and specialty tobaccos, and blends thereof. Such tobacco cut filler can be provided in the form of tobacco laminae; volume expanded or puffed tobacco laminae; processed tobacco stems such as cut-rolled or cut-puffed stems; reconstituted tobacco materials, such as (i) deproteinated tobacco materials described in U.S. Pat. Nos. 4,887,618 to Bernasek et al and 4,941,484 to Clapp et al, (ii) a phosphate-containing reconstituted tobacco material described in U.S. Pat. Nos. 3,353,541 and 3,420,241 to Hind et al. and 3,386,449 to Hind, as well as U.S. Patent application Ser. Nos. 406,637, filed Sep. 13, 1989 now U.S. Pat. No. 4,987,906 to Young, et al., and 461,216, filed Jan. 5, 1990, (iii) a reconstituted tobacco material described in U.S. Patent application Ser. No. 272,156, now U.S. Pat. No. 4,962,774 to Thomasson, et al., filed Nov. 16, 1988 and *Tobacco Encyclopedia* edit. by Voges, p. 389, TJI (1984), (iv) the reconstituted tobacco materials described in U.S. Patent application Ser. Nos. 416,332, filed Sep. 29, 1989 and 414,833, filed Sep. 29, 1989; or blends thereof.

Smokable materials can be cased and top dressed as is conventional during various stages of cigarette manufacture. For example, flavoring agents can be applied to the smokable material as is commonly performed when cigarette cut filler is processed. Suitable flavoring agents include vanillin, cocoa, licorice, menthol, and the like. Flavor modifying agents can be applied to the smokable material. A flavor modifying agent in the form of levulinic acid can be applied to the smokable material (e.g., in amounts ranging from about 0.01 to about 2 percent, normally from about 0.1 to about 1 percent, preferably about 0.2 to about 0.6 percent, based on the dry weight of the smokable material). Another flavor modifying agent in the form of potassium carbonate can be applied to the smokable material (e.g., in amounts of less than about 5 percent, normally about 1 to about 3 percent, based on the dry weight of the smokable material). Aerosol forming materials and humectants, such as glycerin and propylene glycol, can be applied to the smokable material. Such components conveniently are applied to the smokable material as casing and top dressing components.

The preferred wrapping material which provides the smokable rod is a cigarette wrapping material having a low air permeability value. Such a wrapping material normally has an air permeability of less than about 5 CORESTA units, often less than about 3 CORESTA units, and frequently less than about 1 CORESTA unit. Typical wrapping materials are cigarette paper wrappers. Suitable wrapping materials are cigarette paper wrappers available as DD-71-1, DD-71-6, MTR-1021, P-2831-60-2, P-2831-60-3, P-2831-60-4, P-2831-60-5, P-2674-110, P-2831-60-1 and DD-100-2 from Kimberly-Clark Corp. Suitable low porosity cigarette paper wrappers are commercially available, and can have various levels of burn chemicals, fluxing agents, etc., incorporated therein. Particularly preferred are cigarette paper wrappers which include an amount of a polymeric film forming agent sufficient to provide a paper having the desirably low air permeability value. For example, a sufficient amount of a solution of a polymeric (e.g., carboxymethyl cellulose or ethylcellulose) film forming agent can be applied to a paper wrapper. The selection of the polymeric film forming agent will be apparent to the skilled artisan.

The optional polymeric film forming agent can be applied to the paper wrapper during the manufacture of the paper, or applied as a print or paint after manufacture of the paper is complete. Typically, the film forming agent is applied to the paper as a dilute solution (e.g., at a concentration of about 0.2 to about 5 weight percent relative to the solvent) for ease of processing. The amount of film forming agent applied to the paper wrapper depends upon factors such as the permeability of the paper and the film forming capabilities of the film forming agent. Typically, the amount of film forming agents employed ranges from about 1 to about 10 percent, based on the dry weight of the paper. For example, a 5 weight percent solution of ethylcellulose in ethanol or sodium carboxymethylcellulose in water can be applied to cigarette paper using a size press, and the paper can be dried to provide a non-wetting, moisture resistant paper wrapper having a porosity of less than about 1 CORESTA unit, preferably less than about 0.5 CORESTA unit.

The smokable rods and the resulting cigarettes can be manufactured in any known configuration using known cigarette making techniques and equipment. Smokable rods often include smokable material wrapped in a single layer of wrapping material, although a double layer of two types of wrapping materials can be employed. See, for example, U.S. Patent application Ser. No. 528,302, filed May 24, 1990, which is incorporated herein by reference.

Cigarettes having smokable rods which are double wrapped with two layers of wrapping material preferably include one of the previously described low porosity paper wrappers as the outer wrappers. The inner wrapper can vary, but typically is a tobacco-containing wrapping material. Exemplary inner wrappers are paper wrappers which include about 3 parts Java tobacco stem parts and about 1 part wood pulp, and are available from Kimberly-Clark Corp. as P-2249-115 and P-2831-23-3. Other suitable inner wrapping materials include tobacco parts and carbonaceous materials, and are available from Kimberly-Clark Corp. as P-2540-94-A, P-2540-94-C and P-2540-94-D. The inner wrapping materials (i) can include burn chemicals (e.g., potassium citrate, potassium acetate or potassium succinate), and/or (ii) act as a substrate for flavors (e.g., menthol or vanillin) or flavor precursors (e.g., vanillin glucoside or ethylvanillin glucoside).

Typically, the smokable rod has a length which ranges from about 30 mm to about 70 mm, preferably about 35 to about 60 mm; and a circumference of about

17 mm to about 27 mm, preferably about 22 mm to about 25 mm. Short smokable rods (i.e., having lengths from about 30 to about 50 mm) can be employed, particularly when smokable materials having a relatively high packing density are employed.

The packing density of the smokable material contained within the outer wrapping material can vary. Typical packing densities for smokable rods of cigarettes of the present invention range from about 150 to about 400 mg/cm^3. Normally, packing densities of such smokable rods range from about 200 to about 380 mg/cm^3, frequently about 250 to about 360 mg/cm^3, particularly when relatively short (i.e., less than 50 mm long) smokable rods are employed.

The cigarettes of the present invention preferably include a filter element, and most preferably a filter element having more than one segment. For example, a preferred filter element has two or more filter segments. Typically the segments of the preferred filter elements each have lengths which ranges from about 10 mm to about 30 mm; and circumferences of about 17 mm to about 27 mm, preferably about 22 mm to about 25 mm. The plug wrap which circumscribes the filter material of each filter segment typically is a conventional paper plug wrap, and can be either air permeable or essentially air impermeable.

Preferred filter materials of one of the filter segments include carbonaceous materials (e.g., activated carbon particles, charcoal particles, or carbon paper). An example of a particularly preferred filter material is provided by gathering a tobacco/carbon paper available as P-144-BAC from Kimberly-Clark Corp. Such filter materials reduce the levels of certain gas phase components from the mainstream smoke which passes to the mouth of the smoker. As such, preferred filter materials of that segment act to reduce the levels of any smoke components which may provide an off-taste or other undesirable characteristics to the mainstream smoke.

Preferred filter materials of another of the filter segments normally include fibrous materials. An example of a suitable filter material is a gathered nonwoven polypropylene web. A particularly preferred nonwoven polypropylene sheet-like web is available as PP-100-F from Kimberly-Clark Corp. Another example of a suitable filter material is a cellulose acetate tow. Particularly preferred cellulose acetate tow items include (i) 8 denier per filament/40,000 total denier, and (ii) 8 denier per filament/15,000 total denier, (iii) 8 denier per filament/25,000 total denier, and (iv) 8 denier per filament/30,000 total denier. Plasticizers, such as triacetin, propylene glycol or triethyl citrate, can be combined with the filler materials.

Another filter segment can have a filter material in the form of a gathered web of nonwoven thermoplastic (i.e., hydrophobic) fibers in intimate contact with a water soluble tobacco extract so as to provide an extract-containing filter material. A highly preferred web is a nonwoven web of polypropylene fibers available as PP 200 SD from Kimberly-Clark Corp. Exemplary filter segments and filter elements are described in U.S. Patent application Ser. Nos. 414,835, filed Sep. 29, 1989 and 518,597, filed May 3, 1990. Such segments can provide enhanced flavor characteristics to the mainstream smoke which passes therethrough.

Yet another filter segment can include a tobacco paper material as the filter material. For example, a filter material can have the form of a gathered web of tobacco paper available as P-144-B from Kimberly-Clark Corp.

The filter element segments suitable for use in this invention can be manufactured using known cigarette filter making techniques. Filter elements can be manufactured from cellulose acetate tow using known techniques. Filter elements can be manufactured from carbon paper, tobacco paper and a sheet-like nonwoven polypropylene web using filter making techniques described in U.S. Pat. No. 4,807,809 to Pryor et al, which is incorporated herein by reference. Alternatively, particles of charcoal or activated carbon can be incorporated into the filter element using a so-called "triple filter" configuration by positioning the particles between two segments of suitable filter materials.

The filter elements can have low, moderate or high filtration efficiencies. Preferred filter elements have minimal mainstream aerosol (i.e., smoke) removal efficiencies while maintaining the desirable draw characteristics of the cigarette. Such minimal smoke removal efficiencies are provided by "low efficiency" filter elements. Low efficiency filter elements have a minimal ability to remove mainstream smoke particulates. See, Keith in Schemeltz's *The Chemistry of Tobacco and Tobacco Smoke*, p. 157 (1972). Generally, low efficiency filter elements provide less than about 40 weight percent mainstream smoke particulate removal efficiency.

Tipping material circumscribes the filter element and an adjacent region of the smokable rod such that the tipping material extends about 3 mm to about 6 mm along the length of the smokable rod. Typically, the tipping material is a conventional paper tipping material. Tipping materials of varying porosities can be employed. For example, the tipping material can be essentially air impermeable, air permeable, or treated (e.g., by mechanical or laser perforation techniques) so as to have a region of perforations, openings or vents thereby providing a means for providing air dilution to the cigarette. The total surface area of the perforations and the positioning of the perforations along the periphery of the cigarette can be varied in order to control the performance characteristics of the cigarette.

For air diluted or ventilated cigarettes of the present invention, the amount of air dilution can vary. Typically, the amount of air dilution for an air-diluted cigarette is greater than about 25 percent, and frequently greater than about 40 percent. The upper limit for air dilution for a cigarette typically is less than about 75 percent, more frequently less than about 65 percent. As used herein, the term "air dilution" is the ratio (expressed as a percentage) of the volume of air drawn through the air dilution means to the total volume of air and aerosol (i.e., smoke) drawn through the cigarette and exiting the extreme mouthend portion of the cigarette. See, Selke et al, *Beitr. Zur Tabak. In.*, Vol. 4, p. 193 (1978).

Cigarettes of the present invention, when smoked, provide a flavorful mainstream aerosol. The mainstream aerosol of such cigarettes can yield low levels of incomplete combustion products as well as low levels of gas phase components. The cigarettes burn at an acceptable rate, and maintain static smolder, at least when smoked under FTC smoking conditions. The cigarettes, when smoked, have an ash and fire cone which is not overly cohesive, and hence, is not overly long. However, the cigarettes also provide an ash and fire cone which exhibit good integrity.

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Cigarettes of the present invention, when smoked, generally yield less than about 20 mg. preferably less than about 10 mg of sidestream "tar" per cigarette, as determined using the apparatus and techniques described by Proctor et al. *Analyst*. Vol. 113, p. 1509 (1988). Such cigarettes normally provide more than about 5 puffs, preferably more than about 6 puffs per cigarette, when smoked under FTC conditions. Normally, cigarettes of the present invention provide less than about 20 puffs, and often less than about 15 puffs, when smoked under FTC conditions.

The following examples are provided in order to further illustrate the invention but should not be construed as limiting the scope thereof. Unless otherwise noted, all parts and percentages are by weight.

EXAMPLE 1

A. Preparation of a Tobacco-Containing Smokable Filler Material

An agglomerated matrix filler is provided as follows:

Into a low shear mixer are charged about 832 parts tap water at ambient temperature, about 757 parts precipitated particulate calcium carbonate available as Albacar 5970 from Pfizer Inc., and about 267 parts molasses. The calcium carbonate has a rosettic structure and an average particle size (i.e., diameter) of about 2 microns. The molasses is available as Refiner's Syrup from Savannah Sugar Co., and has a solids/water content of about 3.7:1. The resulting mixture is agitated for about 5 to about 10 minutes to provide a slurry having a solids content of about 52 percent and a viscosity of about 1,200 cps as measured by a Brookfield LVT viscometer with cylindrical LV spindle No. 4.

The slurry is spray dried by continuously pumping the slurry at about 6 lbs./min. at a feed pressure of about 475 to about 500 psig to a spray dryer. The spray dryer is a Bowen Type commercial unit equipped with an SD-046 nozzle, and operated in a commercial mode. The inlet temperature is about 470° F., and the outlet temperature is about 260° F. The resulting spray dried particles have a generally spherical shape, and a moisture content of below about 2 percent. The particles are screened to a particle size of −70/+200 US Mesh.

The spray dried particles are placed on a 12 inch by 36 inch steel tray to a thickness of about 0.5 inch. The tray then is passed into a continuous belt furnace at a rate of about 8 to about 12 inches/min., and is subjected to heating under nitrogen atmosphere at above about 600° C. for about 10 minutes, and at above about 400° C. for about 20 minutes. The oven is set at about 720° C., and the tray is subjected to a maximum air temperature of about 670° C. during that time. The heated particles are removed from the furnace into a cooling zone for about 1 hour under nitrogen atmosphere, and cooled to ambient temperature.

The calcined particles so collected are black, are spherical in shape, are free flowing, and resist wetting. The particles are about 93 percent calcium carbonate, and exhibit a bulk density of about 0.5 g/cm^3. The particles each are an agglomerated matrix of a plurality of precipitated calcium carbonate particles spaced within a carbonaceous material.

The tobacco-containing smokable filler material is provided as follows:

Into tap water at ambient temperature and maintained at high shear in a blender is charged about 2 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules Inc. Then, about 4 parts glycerin is charged into the water. After a consistent slurry is provided, about 6 parts spray dried tobacco extract is charged into the slurry. Then, about 18 parts of the previously described calcined agglomerated matrix filler particles are folded into the slurry. The resulting slurry, which is an intimate mixture of the aforementioned components, has a solids content of about 25 percent, and exhibits a pH of about 7.

The slurry is cast to about a 0.02 inch thickness onto a high density polyethylene sheet and air dried. The resulting tobacco-containing smokable filler material is a very dark brown sheet having (i) a thickness of about 0.01 inch, (ii) a density of about 0.5 g/cm^3, (iii) a moisture content of about 2 to about 6 percent, and (iv) a flexible and pliable character. The sheet is provided in strip form, about 2 inches by about 3 inches in size. The strips are shredded at about 32 cuts per inch to provide a combustible tobacco-containing smokable cut filler.

B. Preparation of a Cigarette

Cigarettes substantially as shown in FIG. 1 are provided as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm, and include a smokable rod having a length of about 57 mm, a first filter segment having a length of about 15 mm and a second filter segment having a length of about 12 mm. The first and second filter segments form a filter element. Each filter segment is attached to each smokable rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and about a 4 mm length of the smokable rod in the region adjacent the filter element. The filter elements are not ventilated.

The smokable rod includes the previously described tobacco-containing smokable filler material in cut filler form.

The first filter segment is provided by gathering a 11.75 inch wide web of tobacco and carbon paper available as P-144-BAC from Kimberly-Clark Corp. using the filter rod forming apparatus described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor et al. The plug wrap for the filter segment is available as Reference No. 5831 from Ecusta Corp. The first filter segment is positioned adjacent the smokable rod.

The second filter segment is provided by gathering a 11.75 inch wide web of non-woven polypropylene web available as PP-100-F from Kimberly-Clark Corp. using the filter rod forming apparatus described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor et al. The plug wrap for the filter segment is available as Reference No. 5831 from Ecusta Corp. The second filter segment is positioned adjacent the first filter segment, at the extreme mouth end of the cigarette.

The cigarette paper wrapper exhibits an air permeability of about 1 CORESTA unit. The cigarette paper is available as MTR-1021 from Kimberly-Clark Corp.

Smokable cigarette rods are provided using known techniques. In particular, the smokable material is circumscribed by a single layer of paper wrap. The weight of the smokable filler material within each cigarette rod is about 0.92 g.

The cigarettes are employed by burning the smokable rod such that the smokable material within the paper wrapper burns to yield smoke. When employed, such cigarettes yield very low levels of visible sidestream smoke and essentially no sidestream odor. Cigarettes smoked and tested in this manner each yield 8.0 puffs,

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18.7 mg wet total particulate matter (WTPM), 1.8 mg nicotine, 4.8 mg water and 4.8 mg glycerin, under FTC smoking conditions. The cigarettes do not self-extinguish during the smolder period experienced during FTC smoking conditions.

EXAMPLE 2

A. Preparation of a Smokable Filler Material

Into tap water at ambient temperature and maintained at high shear in a blender is charged about 3 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules Inc. Then, about 6 parts glycerin is charged into the water. After a consistent slurry is provided, about 91 parts of the calcined agglomerated calcium carbonate described in Example 1 is folded into the slurry. The resulting slurry, which is an intimate mixture of the aforementioned components, has a solids content of about 25 percent, and exhibits a pH of about 7.

The slurry is cast to about a 0.02 inch thickness onto a flat high density polyethylene sheet and air dried. The resulting smokable filler material is a very dark brown sheet having (i) a thickness of about 0.01 inch, (ii) a density of about 0.5 g/cm^3, (iii) a moisture content of about 2.5 to about 6 percent, and (iv) a flexible and pliable character. The sheet is provided in strip form, about 2 inches by about 3 inches in size. The strips are shredded at about 32 cuts per inch to provide a smokable cut filler.

The smokable filler material has a powder mixture applied to the surface thereof. The powder mixture is about 9 parts cocoa powder and about 1 part iron oxide, and the powder mixture is applied such that the resulting smokable filler material includes about 3 percent of that powder mixture. The powder mixture provides a brown color to the combustible smokable cut filler.

B. Preparation of a Cigarette

Cigarettes substantially as shown in FIG. 3 are provided as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm, and include a smokable rod having a length of about 57 mm, a first filter segment having a length of 15 mm and a second filter segment having a length of about 12 mm. The first and second segments form a filter element. Each filter segment is attached to each smokable rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and about a 4 mm length of the smokable rod in the region adjacent the filter element. The filter elements are ventilated to about 60 percent air dilution by providing a ring of perforations through the tipping paper and plug wrap of the filter element circumscribing the cigarette about 12 mm from the extreme mouthend thereof.

The smokable rod includes two longitudinally positioned segments of smokable material within two layers of wrapper. The inner surface of the outer wrapper directly contacts the outer surface of the inner wrapper. The inner wrapper circumscribes the smokable material. The first segment of smokable material is positioned at the end of the smokable rod which is to be lit, and the second segment of smokable material is positioned at the end of the smokable rod which is adjacent the filter element. Each segment extends about 28.5 mm along the smokable rod.

The first segment of smokable material is about 0.6 g of a blend of about 65 parts of the previously described smokable filler material and 35 parts tobacco cut filler (strands of tobacco laminae cut at about 32 cuts per inch). The tobacco cut filler portion is a blend of about 30 parts volume expanded flue-cured tobacco, about 20 parts volume expanded Oriental tobacco, about 45 parts flue-cured tobacco, and about 5 parts of a spray dried aqueous Burley tobacco extract. The tobacco cut filler then is top dressed with a mixture of glycerin and potassium carbonate, such that the resulting cut filler includes about 91 percent tobacco, about 3 percent potassium carbonate and about 6 percent glycerin.

The second segment is composed entirely of about 0.6 g of the previously described smokable filler material.

The first filter segment is provided by gathering a 11.75 inch wide web of tobacco and carbon paper available as P-144-BAC from Kimberly-Clark Corp. using the filter rod forming apparatus described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor et al. The plug wrap for the filter segment is available as Reference No. 5831 from Ecusta Corp. The first filter segment is positioned adjacent the smokable rod.

The second filter segment is cellulose acetate tow (8 denier per filament/40,000 total denier) which is plasticized with triacetin, and is circumscribed by nonporous paper plug wrap. The second filter segment is positioned adjacent the first filter segment, at the extreme mouth end of the cigarette.

The cigarette paper outer wrapper of the smokable rod exhibits an air permeability of about 0 CORESTA unit. The paper includes about 4.2 percent potassium citrate and about 1.1 percent sodium carboxymethylcellulose. The cigarette paper is available as P-2831-60-1 from Kimberly-Clark Corp.

The inner wrapper of the smokable rod is a tobacco-containing paper available as P-2831-23-3 from Kimberly-Clark Corp.

The cigarettes are employed by burning the smokable rod such that the smokable material within the paper wrapper burns to yield smoke. When employed, such cigarettes yield very low levels of visible sidestream smoke and essentially no sidestream odor. Cigarettes smoked and tested in this manner each yield 9.5 puffs, 5.2 mg wet total particulate matter (WTPM), 0.5 mg nicotine, 0.5 mg water and 1.5 mg glycerin, under FTC smoking conditions. The cigarettes do not self-extinguish during the smolder period experienced during FTC smoking conditions.

EXAMPLE 3

A smokable filler material is prepared as follows:

Into about 300 ml tap water at ambient temperature is dispersed about 5 g of a high viscosity ammonium alginate available as Amoloid HV from Kelco Division of Merck & Co., Inc. To this is charged about 6 g glycerin, and then about 89 g of the calcined agglomerated calcium carbonate described in Example 1. The resulting slurry is agitated for about 15 minutes using an egg beater type mixer, until the slurry exhibits a smooth texture. The slurry then is cast onto a high density polyethylene sheet at a thickness of about 0.02 inch and air dried. The resulting sheet exhibits good tensile strength, exhibits a flexible and pliable character, is water resistant, and does not undergo any significant amount of cracking during drying. The resulting sheet has a moisture content of about 20 percent, and a thickness of about 0.02 inch. The sheet is shredded at 32 cuts per inch to provide a combustible smokable cut filler.

EXAMPLE 4

A tobacco-containing smokable filler material is prepared as follows:

Into about 300 ml tap water at ambient temperature is dispersed about 5 g of the ammonium alginate described in Example 3. To this is charged about 6 g glycerin, then about 2 g diammonium phosphate, and then about 5 g of a spray dried aqueous extract of Burley tobacco. To this is charged about 82 g of the calcined agglomerated calcium carbonate described in Example 1. The resulting slurry is agitated gently using an egg beater type mixer until the slurry exhibits a smooth texture. The slurry then is cast onto a high density polyethylene sheet surface at a thickness of about 0.02 inch and air dried. The resulting sheet exhibits good tensile strength, exhibits a flexible and pliable character, is water resistant, and does not undergo any significant amount of cracking during drying. The resulting sheet has a moisture content of about 20 percent and a thickness of about 0.02 inch. The sheet is shredded at 32 cuts per inch to provide a combustible smokable cut filler.

EXAMPLE 5

A smokable filler material is prepared as follows:

Into about 300 ml tap water at ambient temperature is dispersed about 5 g of the ammonium alginate described in Example 3. To this is charged about 20 g glycerin, and then about 40 g of the calcined agglomerated calcium carbonate described in Example 1. The resulting slurry is mixed gently for about 15 minutes using an egg beater type mixer. The resulting slurry is extruded at ambient temperature using a 50 ml syringe through a die having a generally circular orifice having a diameter of about 1 mm. The extrudate exits the die into a solution of about 98 parts tap water and about 2 parts calcium chloride ambient temperature. Within about 30 seconds, extrudate is removed from the aqueous calcium chloride solution, and resembles a cylinder having a diameter of 1 mm. The extrudate is dried at ambient conditions. The extrudate is passed through the nip of two closely spaced, smooth surfaced metal rollers to produce ribbon about 2 mm wide and about 0.4 mm thick. The resulting material is suitable for use as a smokable filler material.

EXAMPLE 6

A tobacco-containing smokable filler material is provided as follows:

Into about 320 parts tap water at ambient temperature is dispersed about 4 parts of the ammonium alginate described in Example 3. To this is charged about 10 parts glycerin, then about 5 parts of powdered Java tobacco laminae, and then about 81 parts of the calcined agglomerated calcium carbonate described in Example 1. The resulting slurry is agitated until the slurry exhibits a smooth texture. The slurry is cast onto a flat high density polyethylene sheet at a thickness of about 0.02 inch, and air dried to a moisture content of about 12 percent and a thickness of about 0.012 inch. The resulting sheet is cut at about 32 cuts per inch to provide a combustible smokable cut filler.

EXAMPLE 7

A. Preparation of a Smokable Filler Material

A tobacco-containing smokable filler material is provided using a paper-making process as follows:

Into about 400 parts tap water at ambient temperature is dispersed about 2 parts hardwood pulp having a Canadian Standard Freeness of about 95. A slurry is provided by agitating the mixture in a high shear blender at high speed for about 4 minutes. Into the slurry is charged about 25 parts of the calcined agglomerated calcium carbonate described in Example 1. As such, the amount of cellulose pulp in the slurry is less than about 12 percent, based on the solids content of the slurry. The resulting slurry is agitated gently to provide a uniform, homogeneous slurry.

The homogeneous slurry is cast from a headbox as a mat onto a 100 mesh (U.S.) fabric. The slurry is metered from the headbox using a rotating drum having retractable metering veins which unload the slurry from the drum to the fabric. The rotating drum moves linearly relative to the surface of the fabric. The ratio of the speed of the perimeter of the rotating drum to the linear speed of the drum is about 1.6:1. A vacuum of about −25 inches water is pulled on the bottom of the fabric to provide a mat having a thickness of about 0.02 inch. A mixture of water, glycerin, spray dried aqueous tobacco extract is sprayed onto both sides of the mat. The aqueous spray dried tobacco extract is about 30 parts spray dried Burley tobacco and about 70 parts spray dried flue cured tobacco. Sufficient mixture is sprayed onto the mat so as to provide a sheet having about 20 parts tobacco extract, about 6 parts glycerin and about 74 parts mat, on a dry weight basis. The mat then is maintained overnight at a temperature of about 76° F. and at a relative humidity of about 60 percent to provide a paper-type material.

The mat then is cut into rectangular strips, about 2 inches by about 3 inches in size. The strip is shredded at 32 cuts per inch using a paper shredder available as Model 52 AM from Michael Business Machines Corp. The resulting strands of smokable cut filler then are dried at about 90° C. in an oven to a moisture level of about 3 percent.

B. Preparation of a Cigarette

Cigarettes substantially as shown in FIG. 3 are provided as follows:

The cigarettes each have a length of 84 mm and a circumference of 24.8 mm, and include a smokable rod having a length of 57 mm, a first filter segment having a length of 15 mm and a second filter segment having a length of 12 mm. The first and second segments form a filter element. Each filter element is attached to each smokable rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and a 4 mm length of the smokable rod in the region adjacent the filter element. The filter elements are ventilated to about 63 percent air dilution by providing a ring of perforations through the tipping paper and plug wrap of the filter element circumscribing the cigarette about 12 mm from the extreme mouthend thereof.

The smokable rod includes the previously described smokable filler material wrapped within two layers of wrapper.

The first filter segment is provided by gathering a 11.75 inch wide web of tobacco and carbon paper available as P-144-BAC from Kimberly-Clark Corp. using the filter rod forming apparatus described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor et al. The plug wrap for the filter segment is available as Reference No. 5831 from Ecusta Corp. The first filter segment is positioned adjacent the smokable rod.

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The second filter segment is cellulose acetate tow (8 denier per filament/40.000 total denier) which is plasticized with triacetin, and is circumscribed by nonporous paper plug wrap. The second filter segment is positioned adjacent the first filter segment, at the extreme mouth end of the cigarette.

The cigarette paper outer wrapper of the smokable rod exhibits an air permeability of about 0 CORESTA unit. The paper includes about 4.2 percent potassium citrate and about 1.1 percent sodium carboxymethylcellulose. The cigarette paper is available as P-2831-60-1 from Kimberly-Clark Corp.

The inner wrapper of the smokable rod is a tobacco containing paper available as P-2831-22-2 from Kimberly-Clark Corp.

The weight of each cigarette is about 1.26 g.

The cigarettes are employed by burning the smokable rod such that the smokable material within the paper wrapper burns to yield smoke. When employed, such cigarettes yield very low levels of visible sidestream smoke and essentially no sidestream odor. Cigarettes smoked and tested in this manner each yield about 9 puffs, 7.3 mg wet total particulate matter (WTPM), 0.74 mg nicotine, 0.5 mg water and 1.2 mg glycerin, under FTC smoking conditions.

EXAMPLE 8

A smokable filler material is provided as follows:

Into about 240 parts tap water is charged about 4 parts of the ammonium alginate described in Example 3, followed by about 17.5 parts glycerin, then about 17.5 parts propylene glycol, and finally about 61 parts of the calcined agglomerated calcium carbonate described in Example 1. The resulting slurry is agitated using an egg beater type mixer, until the slurry exhibits a smooth texture. The slurry is cast onto a high density polyethylene sheet at a thickness of about 0.015 inch and air dried. The resulting dried sheet has a thickness of about 0.011 inch, an exhibits a density of about 0.745 g/cm^3.

Cigarettes are provided from the smokable filler material as follows:

The smokable material is circumscribed by a reconstituted tobacco paper-type wrapper containing Java tobacco stem parts and wood pulp. The inner wrapper is available as P-2831-23-3 from Kimberly-Clark Corp. The inner wrapper then is circumscribed by a paper wrapper available as P-2831-60-1 from Kimberly-Clark Corp. The cigarette includes the filter element and tipping material, substantially as described in Example 7.

EXAMPLE 9

A smokable filler material is provided as follows:

Into about 720 parts tap water is charged about 12 parts of the ammonium alginate described in Example 3, followed by about 48 parts glycerin, and finally about 40 parts of the calcined agglomerated calcium carbonate described in Example 1. The resulting slurry is agitated using an egg beater type mixer, until the slurry exhibits a smooth texture. The slurry is cast onto a high density polyethylene sheet at a thickness of about 0.015 inch and air dried. The resulting dried sheet has a thickness of about 0.007 inch, and exhibits a density of about 0.503 g/cm^3.

Cigarettes are provided from the smokable filler material as follows:

The smokable material is circumscribed by a reconstituted tobacco paper-type wrapper containing Java tobacco stem parts and wood pulp. The inner wrapper is available as P-2831-23-3 from Kimberly-Clark Corp. The inner wrapper then is circumscribed by a paper wrapper available as P-2831-60-1 from Kimberly-Clark Corp. The cigarette includes the filter element and tipping material, substantially as described in Example 7.

EXAMPLE 10

A smokable filler material is provided as follows:

Into about 720 parts tap water is charged about 12 parts of the ammonium alginate described in Example 3, followed by about 24 parts glycerin, then about 24 parts propylene glycol, and finally about 40 parts of the calcined agglomerated calcium carbonate described in Example 1. The resulting slurry is agitated using an egg beater type mixer, until the slurry exhibits a smooth texture. The slurry is cast onto a high density polyethylene sheet at a thickness of about 0.015 inch and air dried. The resulting dried sheet has a thickness of about 0.007 inch, and exhibits a density of about 0.47 g/cm^3.

Cigarettes are provided from the smokable filler material as follows:

The smokable material is circumscribed by a reconstituted tobacco paper-type wrapper containing Java tobacco stem parts and wood pulp. The inner wrapper is available as P-2831-23-3 from Kimberly-Clark Corp. The inner wrapper then is circumscribed by a paper wrapper available as P-2831-60-1 from Kimberly-Clark Corp. The cigarette includes the filter element and tipping material, substantially as described in Example 7.

EXAMPLE 11

A tobacco-containing smokable filler material is provided as follows:

Into about 400 ml tap water at ambient temperature is charged about 24.2 g glycerin and about 12.1 g propylene glycol, and the resulting mixture is agitated at a high rate using a high shear blender. To the resulting mixture is added about 7.2 g of the ammonium alginate described in Example 3, and the mixture which results is agitated at high speed using a blender for about 15 minutes in order to disperse the alginate in the liquid and hydrolyze the alginate. About 10 g precipitated calcium carbonate available as Code No. 2A from Pfizer Inc. is dispersed in about 100 ml of tap water; charged into the aqueous slurry of glycerin, propylene glycol and alginate; and the resulting mixture is agitated until a smooth slurry results. The resulting slurry is transferred to an egg beater type mixer, and about 10 g of the agglomerated calcium carbonate described in Example 1 is added to the slurry while the mixture is gently agitated. Into the slurry is added about 36.4 g of a mixture of volume expanded flue-cured and Burley tobacco laminae which has been ground to a particle size of −35/+80 US Mesh, and the mixture is gently agitated. About 3 g diammonium phosphate is dissolved in about 200 g water; charged into the slurry; and the resulting slurry is gently agitated for about 5 minutes.

The resulting slurry is cast to about a 0.03 inch thickness on a high density polyethylene sheet and air dried for about 80 minutes. Then, an aqueous solution of 1 percent calcium chloride is sprayed onto the top side of the cast slurry so as to apply about 1 percent calcium chloride to the cast slurry, on a dry weight basis. The slurry then is allowed to air dry to provide a relatively stiff sheet. The resulting sheet is shredded at about 32 cuts per inch to provide a smokable filler material.

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EXAMPLE 12

Particles of calcium carbonate agglomerated with an alginate are provided as follows:

Into a blender is charged about 750 ml tap water, and then about 20 g glycerin. While the mixture is gently agitated, about 10 g of the ammonium alginate described in Example 3 is slowly added thereto, so as to disperse the alginate in the water. The resulting mixture is transferred into a 1 liter jar, sealed, and gently rolled overnight to hydrate the alginate.

A slurry of 250 g precipitated calcium carbonate available as Code No. 2A from Pfizer Inc. in 250 g tap water is provided. Then, the slurry is added to 200 g of the water/glycerin/alginate mixture. The resulting slurry is agitated gently so as to provide a slurry having a smooth texture.

The slurry is cast onto a high density polyethylene sheet at a thickness of about 0.04 inch, and air dried to provide pieces of dried sheet about 6 inches by about 6 inches in size. The resulting dried sheet is hand ground to a fine particle size and screened to −50 US Mesh.

A tobacco-containing smokable filler material is prepared as follows:

Into a high shear blender is charged about 225 ml tap water, and into the water is dispersed about 5 g of the ammonium alginate described in Example 3. The resulting mixture is gently agitated at ambient temperature for about 15 minutes, until the alginate is hydrated. Then, about 20 g glycerin is added to the mixture, followed by about 25 ml tap water. To the mixture is added about 16.7 g of an "American blend" of tobacco cut filler which has been ground to a powder. Then, about 25 ml tap water is added to the mixture. The resulting mixture is agitated until a smooth slurry results. To the slurry is added a mixture of about 13.8 g of the calcined agglomerated calcium carbonate described in Example 1 and about 13.8 g of particles of calcium carbonate agglomerated with ammonium alginate. The resulting slurry is agitated until the slurry exhibits a smooth texture. The resulting slurry is cast onto a high density polyethylene sheet at a thickness of about 0.025 inch and air dried.

EXAMPLE 13

A smokable filler material is provided as follows:

Into about 2,000 ml tap water is charged about 400 g of the calcined agglomerated calcium carbonate described in Example 1. The resulting slurry is agitated using a magnetic stirring bar, and into the slurry is added in a drop-wise manner about 500 ml of a 3 molar aqueous hydrochloric acid solution. The slurry then is filtered and washed with about 4,000 ml water. The resulting digested agglomerated matrix calcium carbonate exhibits a bulk density and weighs about 104 g.

Into a high shear mixer set at high speed containing about 430 g tap water is added about 5 g sodium carboxymethylcellulose available as CMC 7HF from Hercules Inc. Then, about 6 g glycerin is charged into the mixture. Agitation is ceased, and about 89 g of the previously described digested agglomerated matrix calcium carbonate is folded into the mixture. The resulting slurry is gently agitated until a smooth slurry results. The slurry is sieved through a 20 US Mesh screen to remove large clumps therefrom. The slurry is cast at about a 0.02 inch thickness and air dried. The resulting sheet has a thickness of about 0.015 inch, and exhibits a density of about 0.31 g/cm^3.

EXAMPLE 14

A tobacco-containing smokable filler material is provided as follows:

Into about 190 ml tap water at ambient temperature is mixed about 24.2 g of glycerin and 12.1 g of propylene glycol. The mixture is agitated using a high shear blender. To this is added about 3.6 g of the ammonium alginate described in Example 3. Agitation is continued for about 15 minutes until the ammonium alginate is completely dispersed and hydrated. Then about 10 g of precipitated calcium carbonate is added slowly and mixed until the material is evenly dispersed and the slurry becomes smooth. Then about 10 g of agglomerated calcium carbonate, as described in Example 1, is added and gently stirred until the mix is uniform. This mixture was cast at 0.02 inches onto a plastic surface. After drying for 1 hour, an aqueous solution of 1 percent calcium chloride is sprayed onto the top side as described in Example 6. This sheet is allowed to dry in air under ambient conditions. Next, into about 300 ml tap water at ambient temperature is added about 3.6 g of ammonium alginate and the mix is agitated until the alginate is dispersed and hydrated. Then about 14.6 g of Burley tobacco powder, about 2.9 g of milled Turkish tobacco, about 18.9 g of milled flue-cured tobacco; and about 13.5 g of propylene glycol is added and mixed until uniform. This mix was cast at about 0.07 inches over the sheet previously described in this Example. The resulting laminated sheet is shredded at 32 cuts per inch.

What is claimed is:

1. A cigarette comprising:

(a) a smokable filler material including an intimate mixture of (i) agglomerated matrix filler in particulate form having particles of inorganic filler spaced within a continuous or semi-continuous phase of a carbonaceous binding material, and (ii) tobacco; and

(b) wrapping material circumscribing the smokable filler material.

2. The cigarette of claim 1 wherein the smokable filler material includes a binding agent.

3. The cigarette of claim 1 wherein the wrapping material is a paper having a porosity of less than about 5 CORESTA units.

4. The cigarette of claim 1 or 3 wherein the agglomerated matrix filler comprises a calcium carbonate component and a carbonaceous component.

5. The cigarette of claim 4 further including tobacco cut filler.

6. The cigarette of claim 4 wherein the agglomerated matrix filler comprises greater than about 90 weight percent calcium carbonate component and greater than about 3 weight percent carbon provided by the carbonaceous component.

7. The cigarette of claim 1 or 3 wherein the agglomerated matrix filler comprises an inorganic component spaced within a continuous or semi-continuous phase of a carbonaceous binding component, and the agglomerated matrix filler is in particulate form exhibiting a particle size of −50/+325 U.S. Mesh.

8. The cigarette of claim 1 further including tobacco cut filler.

9. The cigarette of claim 1 wherein the smokable material includes up to about 50 weight percent tobacco, about 45 to about 90 percent agglomerated matrix filler; up to about 20 weight percent binding agent;

and up to about 20 weight percent aerosol forming material.

10. A cigarette comprising:

(a) smokable filler material including an intimate mixture of (i) agglomerated matrix filler, (ii) tobacco, and (iii) a binding agent which includes ammonium alginate; and

(b) wrapping material circumscribing the smokable filler material.

11. The cigarette of claim 1, 2 or 10 wherein the tobacco has the form of a tobacco extract.

12. The cigarette of claim 11 wherein the smokable filler material includes an aerosol forming material.

13. The cigarette of claim 11 further including tobacco cut filler.

14. A smokable filler material comprising an agglomerated matrix filler material in particulate form having particles of inorganic filler spaced within a continuous or semi-continuous phase of a carbonaceous binding material.

15. The smokable filler material of claim 14 including a binding agent.

16. The smokable filler material of claim 14 or 15 including an aerosol forming material.

17. The smokable filler material of claim 16 wherein the aerosol forming material includes a polyhydric alcohol.

18. The smokable filler material of claim 16 further comprising tobacco.

19. The smokable filler material of claim 14 wherein the agglomerated matrix filler comprises an inorganic component spaced within a continuous or semi-continuous phase of a carbonaceous binding component, and the agglomerated matrix filler is in particulate form exhibiting a particle size of −50/+325 U.S. Mesh.

20. The smokable filler material of claim 19 wherein the inorganic component includes particles of calcium carbonate.

21. The smokable filler material of claim 19 wherein the agglomerated matrix filler comprises greater than about 90 weight percent inorganic component and greater than about 3 weight percent carbon provided by the carbonaceous component.

22. The smokable filler material of claim 21 further comprising tobacco.

23. The smokable filler material of claim 19 including about 60 to about 95 weight percent agglomerated matrix filler, up to about 20 percent binding agent, and up to about 20 weight percent aerosol forming material.

24. The smokable filler material of claim 23 further comprising tobacco.

25. The smokable filler material of claim 19 consisting essentially of about 60 weight percent agglomerated matrix filler, up to about 20 weight percent binding agent, and up to about 20 weight percent aerosol forming material.

26. The smokable filler material of claim 25 further comprising tobacco.

27. The smokable filler material of claim 22, 24 or 26 wherein the tobacco has the form of a tobacco extract.

28. The smokable filler material of claim 22, 24 or 26 including up to about 50 weight percent tobacco, about 45 to about 90 weight percent agglomerated matrix filler, up to about 20 weight percent binding agent, and up to about 20 weight percent aerosol forming material.

29. The smokable filler material of claim 14 or 19 wherein the agglomerated matrix filler is (i) in particulate form, and (ii) exhibits a bulk density of less than about 1 g/cm^3.

30. The smokable filler material of claim 14, 15 or 19 further comprising tobacco.

31. The smokable filler material of claim 30 wherein the tobacco has the form of an extract.

32. A cigarette comprising:

(a) smokable filler material including agglomerated matrix filler in particulate form having particles of inorganic filler spaced within a continuous or semi-continuous phase of a carbonaceous binding material; and

(b) wrapping material circumscribing the smokable filler material.

33. The cigarette of claim 32 wherein the smokable filler material includes a binding agent.

34. The cigarette of claim 32 wherein the smokable material includes an aerosol forming material.

35. The cigarette of claim 32 wherein the wrapping material is a paper having a porosity of less than about 5 CORESTA units.

36. The cigarette of claim 32 or 35 wherein the agglomerated matrix filler comprises a calcium carbonate component and a carbonaceous component.

37. The cigarette of claim 36 wherein the smokable filler material comprises about 60 to about 95 weight percent agglomerated matrix filler, up to about 20 weight percent binding agent, and up to about 20 weight percent aerosol forming material.

38. The cigarette of claim 36 wherein the agglomerated matrix filler comprises greater than about 90 weight percent calcium carbonate component and greater than about 3 weight percent carbon provided by the carbonaceous component.

39. The cigarette of claim 32 or 35 wherein the agglomerated matrix filler comprises an inorganic component spaced within a continuous or semi-continuous phase of a carbonaceous binding component, and the agglomerated matrix filler is in particulate form exhibiting a particle size of −50/+325 U.S. Mesh.

40. The cigarette of claim 35 further including tobacco cut filler.

41. A cigarette comprising:

(a) smokable filler material including (i) agglomerated matrix filler, and (ii) a binding agent including ammonium alginate; and

(b) wrapping material circumscribing the smokable filler material.

42. The cigarette of claim 32, 33 or 41 further including tobacco cut filler.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,105,836

DATED : April 21, 1992

INVENTOR(S) : Jeffery S. Gentry, et al.

It is certified that error appears in the above—identified patent and that said Letters Patent is hereby corrected as shown below:

In the Title Page under [75] Inventors:

Line 3, after "Mead; insert --of New Jersey--.

Page 2 following U.S. PATENT DOCUMENTS, add:

--OTHER PUBLICA ONS, APV Anhydro Bulletin No. 165 and APV Anhydro Bulletin No. 701--.

Col. 24, line 62, "80" should be --30--.
Col. 27, line 55, after "60" insert --to about 90--.

Signed and Sealed this

Twenty-first Day of September, 1993

Bruce Lehman

Attest:

Sandra L. Morton

Attesting Officer

BRUCE LEHMAN

Commissioner of Patents and Trademarks

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US005271419A

Abandoned 6-2-97

United States Patent [19]

Arzonico et al.

[11] Patent Number: 5,271,419

[45] Date of Patent: * Dec. 21, 1993

[54] CIGARETTE

[75] Inventors: Barbara W. Arzonico, Lewisville; Richard L. Blakley, Pfafftown; Sharon P. Dunlap, Walnut Cove; Jeffery S. Gentry, Pfafftown; Kathy A. Hege, Advance; Mark L. Raker, Clemmons; Gary R. Shelar, Greensboro, all of N.C.

[73] Assignee: R. J. Reynolds Tobacco Company, Winston-Salem, N.C.

[*] Notice: The portion of the term of this patent subsequent to Nov. 16, 2010 has been disclaimed.

[21] Appl. No.: 759,266

[22] Filed Sep. 13, 1991

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 414,833, Sep. 29, 1989, Pat. No. 5,074,321, and a continuation-in-part of Ser. No. 661,747, Feb. 27, 1991.

[51] Int. Cl.[5] A24D 1/02

[52] U.S. Cl. 131/365; 131/364; 131/336

[58] Field of Search 131/365, 364, 335, 336

[56] References Cited

U.S. PATENT DOCUMENTS

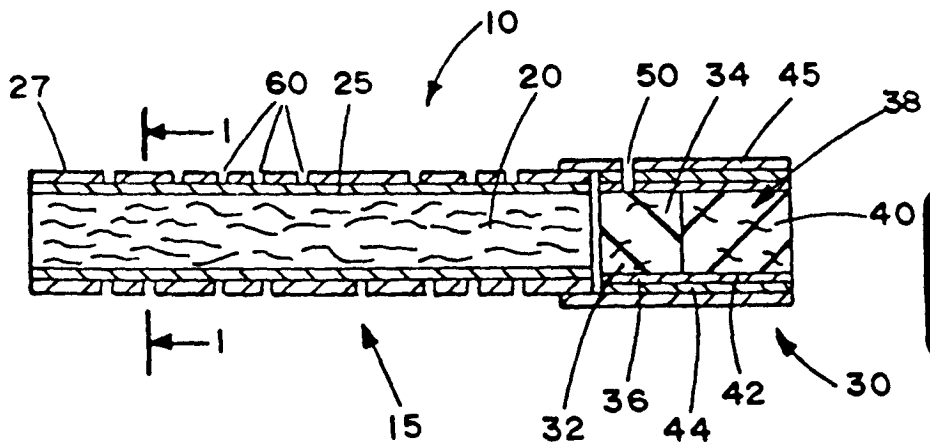
3,648,711	3/1972	Berger et al.	131/210 X
3,894,545	7/1975	Crellin et al.	131/207 X
4,062,368	12/1977	Crellin et al.	131/207 X
5,074,321	12/1991	Gentry et al.	131/365 X
5,137,034	8/1992	Perfetti et al.	131/335 X

Primary Examiner—V. Millin
Assistant Examiner—J. Doyle

[57] ABSTRACT

A cigarette includes a charge or roll of smokable material (e.g., tobacco cut filler) circumscribed by two layers of paper wrapping materials. The first or inner wrapping material includes an inorganic filler material and tobacco material within the web. The inner wrapping material also can include a water soluble salt burn chemical and a carbonaceous material within the web. The second or outer wrapping material circumscribes and overwraps the first wrapping material, has a cellulosic base web and inorganic filler material, and exhibits a low inherent air permeability. The outer wrapping material can include a magnesium hydroxide filler, and exhibits an inherent air permeability of below about 15 CORESTA units and a net air permeability above about 40 CORESTA units. The cigarette is capable of sustaining smolder under FTC smoking conditions while yielding very low levels of visible sidestream smoke. The cigarette includes a filter element having 2 or more longitudinally positioned segments, and one of the segments includes a carbonaceous material.

25 Claims, 2 Drawing Sheets



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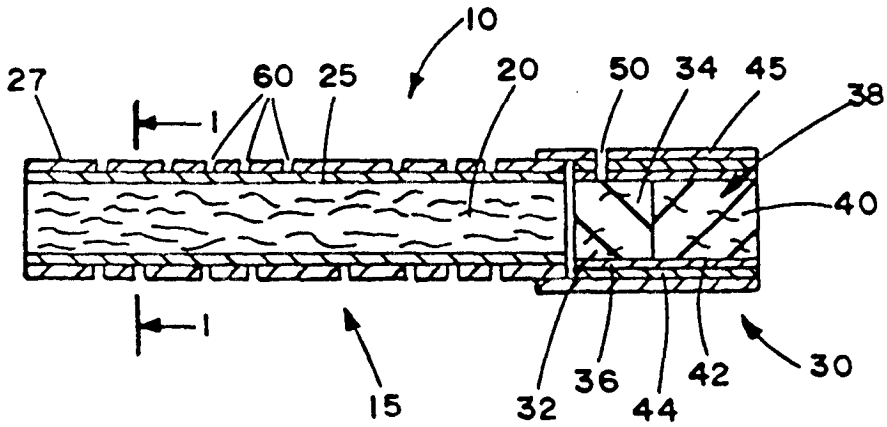

FIG. 1

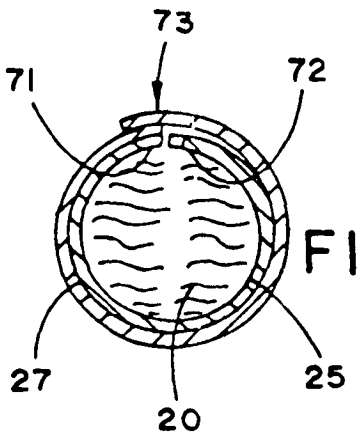

FIG. 1A

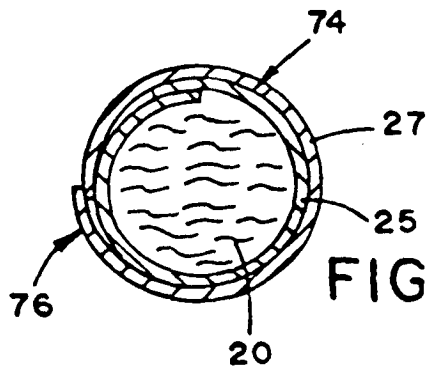

FIG. 1B

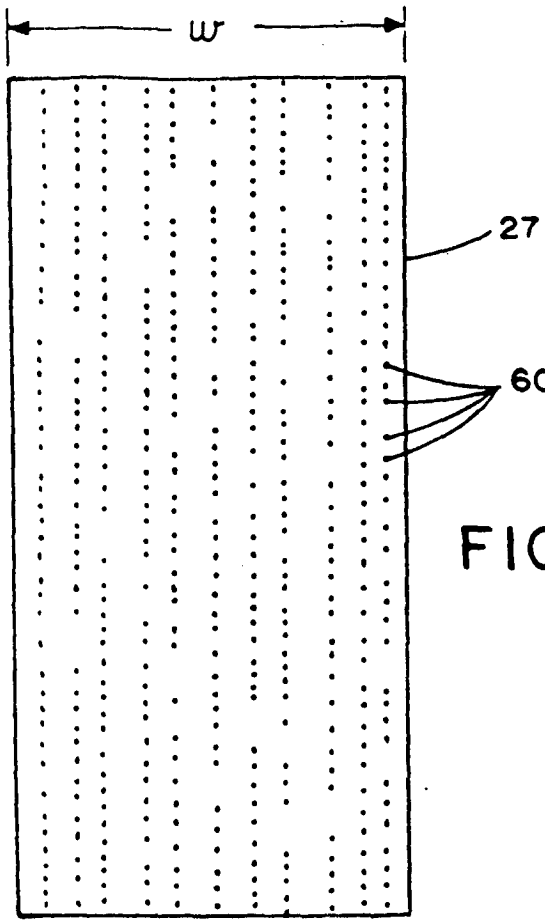

FIG. 2

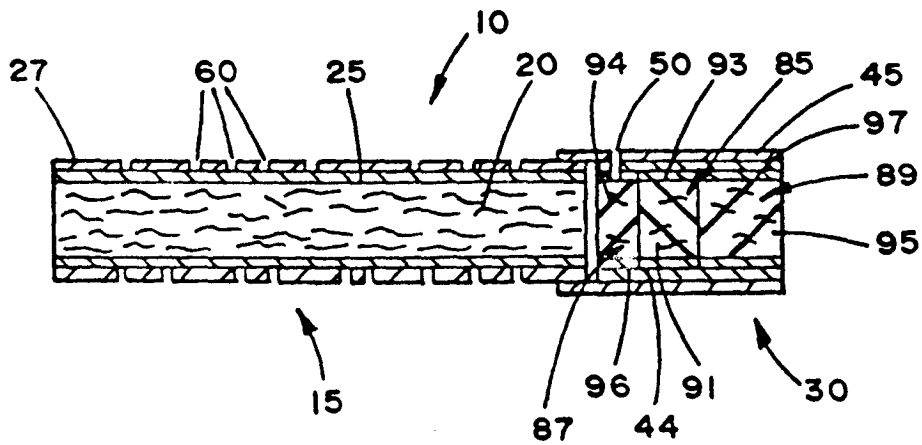

FIG. 3

CIGARETTE

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of co-pending U.S. patent application Ser. No. 414,833, filed Sep. 29, 1989, now U.S. Pat. No. 5,074,321 and U.S. patent application Ser. No. 661,747, filed Feb. 27, 1991, still pending.

BACKGROUND OF THE INVENTION

The present invention relates to cigarettes which burn tobacco, and in particular to cigarettes, which when smoked, generate low amounts of sidestream "tar" and sustain smolder at least during FTC smoking conditions.

Popular smoking articles, such as cigarettes, have a substantially cylindrical rod shaped structure and include a charge of smokable material such as shredded tobacco (e.g., in cut filler form) surrounded by a paper wrapper thereby forming a so-called "tobacco rod." Normally, a cigarette has a cylindrical filter element aligned in an end-to-end relationship with the tobacco rod. Typically, a filter element includes cellulose acetate tow circumscribed by plug wrap, and is attached to the tobacco rod using a circumscribing tipping material. It also has become desirable to perforate the tipping material and plug wrap, in order to provide dilution of drawn mainstream smoke with ambient air.

Cigarettes are employed by the smoker by lighting one end thereof and burning the tobacco rod. The smoker then receives mainstream smoke into his/her mouth by drawing on the opposite end (e.g., the filter end) of the cigarette. During the time that the cigarette is not being drawn upon by the smoker, it remains burning, and sidestream smoke is generated. Sidestream smoke is smoke which directly enters the atmosphere from the lit end of the cigarette. Sidestream smoke diffuses into the atmosphere, and the characteristic visible nature thereof may be perceived negatively by some individuals. Thus, certain cigarette smokers have indicated a desire to decrease the levels of visible sidestream smoke generated by their cigarettes.

The relative amount of visible sidestream smoke generated by a burning cigarette is related to the amount of sidestream "tar" generated by that burning cigarette. Typical cigarettes of about 84 mm length (e.g., having a tobacco rod length of about 57 mm and a filter element length of about 27 mm) often yield about 25 to about 35 mg of sidestream "tar" per cigarette. See, Proctor, et al., *Analyst*, Vol. 113, p. 1509 (1988), for an apparatus and technique for determining the sidestream "tar" of a cigarette.

Numerous cigarettes which reportedly yield relatively low levels of visible sidestream smoke have been proposed. See, for example, U.S. Pat. Nos. 4,108,151 to Martin, 4,225,636 to Cline; 4,231,377 to Cline; 4,407,308 to Baker; 4,420,002 to Cline; 4,450,847 to Owens; 4,461,311 to Mathews; 4,561,454 to Guess; 4,624,268 to Baker, et al.; 4,637,410 to Luke; 4,805,644 to Hampl, Jr., et al.; 4,881,557 to Martin; 4,915,118 to Kaufman, et al.; 4,924,888 to Perfetti, et al.; 4,941,485 to Perfetti, et al. and 4,998,541 to Perfetti, et al.; as well as European Patent Application No. 402,059.

It would be desirable for the cigarette manufacturer to provide a good tasting cigarette which (i) provides good smoking satisfaction, (ii) sustains smolder at least during FTC smoking conditions, and (iii) generates low levels of sidestream "tar" and hence low levels of visible sidestream smoke.

SUMMARY OF THE INVENTION

The present invention relates to a cigarette which delivers good tobacco flavor, pleasure and satisfaction while generating relatively low levels of sidestream "tar." Such cigarettes also exhibit extremely low levels of visible sidestream smoke as well as low levels of sidestream odor. Cigarettes of the present invention (i) have a weight which is not overly excessive, (ii) yield an acceptable ash and fire cone, (iii) yield acceptable smolder properties, and (iv) yield a burn rate which is acceptable. Further, such cigarettes have a tendency to (i) burn back uniformly during use, and (ii) not provide visible staining of the outer wrap immediately behind the char line during use. Preferred cigarettes burn back slowly during static smolder resulting in the combustion of a relatively low amount of smokable material, while maintaining a tendency to sustain smolder.

Cigarettes of the present invention include a charge or roll of smokable material contained in two layers of circumscribing outer wrapping materials to form a so-called "tobacco rod." The tobacco rod is such that a first (i.e., inner) wrapping material circumscribes the smokable material, and a second (i.e., outer) wrapping material circumscribes the first wrapping material. The smokable material is a smokable filler material comprising tobacco cut filler material. Normally, the smokable material is all tobacco cut filler material, and preferably that cut filler material has been cased and/or top dressed.

The second or outer layer of wrapping material surrounding the roll of smokable material is a paper which most preferably has a relatively low inherent air permeability. Wrapping materials having a low inherent air permeability or low porosity typically exhibit a porosity or air permeability below about 15 CORESTA units, normally below about 10 CORESTA units, often below about 8 CORESTA units, and frequently about 5 CORESTA units or less. A CORESTA unit is a measure of the linear air velocity which passes through a 1 cm^2 area of wrapper at a constant pressure of 1 centibar. See CORESTA Publication ISO/TC 126/SC 1 N159E (1986). The second wrapping material most preferably has a net porosity which is greater than the inherent porosity thereof, particularly when that wrapping material includes a magnesium hydroxide filler. Typically, the second wrapping material is perforated (e.g., electrostatically perforated) to have a net porosity of about 50 to about 225 CORESTA units.

The first or inner wrapping material surrounding the roll of smokable material most preferably is a paper containing a tobacco material. The first wrapping material preferably has a sufficiently high level of at least one salt additive which can act to sustain static burn of the tobacco rod, at least when such cigarettes are smoked under FTC smoking conditions. The salt can be an essentially water insoluble inorganic salt (e.g., particles of calcium carbonate), a water soluble inorganic salt (e.g., potassium chloride), or a water soluble salt (e.g., potassium citrate). Mixtures of essentially water insoluble and water soluble salts can be employed. Certain first wrapping materials can contain a carbonaceous material. The first wrapping material most preferably exhibits an inherent air permeability above about 20 CORESTA units. The first wrapping material can be

perforated to yield a wrapping material having yet higher net porosity.

Cigarettes of the present invention each include a filter element which acts as a mouthpiece. The filter element includes a carbonaceous material. The filter element preferably includes 2 or more filter segments which are longitudinally positioned within the filter element, and at least one of the filter segments includes a carbonaceous material (e.g., an activated carbon material or an activated charcoal material in a particulate or granular form).

Cigarettes can be air diluted (e.g., by perforating the tipping material in the region which overlies the filter elements or by other such air dilution means). Normally, preferred cigarettes employ moderate to low efficiency filter elements. See, Keith in Schemeltz's *The Chemistry of Tobacco and Tobacco Smoke*, p. 157 (1972). Normally, the filter element is ventilated to provide a cigarette having an air dilution between about 25 and about 75 percent. As used herein, the term "air dilution" is the ratio (expressed as a percentage) of the volume of air drawn through the air dilution means to the total volume of air and smoke drawn through the cigarette and exiting the extreme mouthend portion of the cigarette. See, Selke, et al., *Beitr. Zur Tabak. In.*, Vol. 4, p. 193 (1978).

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of a cigarette of the present invention;

FIGS. 1A and 1B are cross-sectional radial views of the cigarette shown in FIG. 1 taken along lines 1—1 in FIG. 1;

FIG. 2 is a diagrammatic illustration of one type of wrapping material which can be employed to provide a tobacco rod of the present invention; and

FIG. 3 is a longitudinal sectional view of a cigarette of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of a cigarette of the present invention is shown in FIG. 1. The cigarette 10 includes a generally cylindrical rod 15 of smokable material 20, such as tobacco cut filler, contained in a first circumscribing inner wrapping material 25 and a second or outer wrapping material 27 circumscribing the first wrapping material. The first and second circumscribing wrapping materials directly contact one another (i.e., the inner surface of the outer wrapping material contacts the outer surface of the inner wrapping material). As such, the outer wrapping material overwraps the inner wrapping material. The rod 15 is hereinafter referred to as a "tobacco rod." The ends of the tobacco rod 15 are open to expose the smokable material.

The cigarette 10 also includes a filter element 30 positioned adjacent one end of the tobacco rod 15 such that the filter element and tobacco rod are axially aligned in an end-to-end relationship, preferably abutting one another. Filter element 30 has a generally cylindrical shape, and the diameter thereof is essentially equal to the diameter of the tobacco rod. The ends of the filter element are open to permit the passage of air and smoke therethrough.

The filter element includes two filter segments which are aligned in an end-to-end relationship, preferably abutting one another. A first filter segment 32 is positioned adjacent the tobacco rod, and includes a first filter material 34, such as a gathered carbon paper or cellulose acetate tow having carbonaceous particles dispersed therein. The first filter material 34 is circumscribed by a wrapping material 36, such as paper plug wrap. A second filter segment 38 is positioned at the extreme mouthend of the cigarette; and includes a second filter material 40, such as gathered cellulose acetate web, plasticized cellulose acetate tow, gathered polyester web, gathered polypropylene web or polypropylene tow. The second filter material 40 is circumscribed by a wrapping material 42, such as a paper plug wrap. The second filter material 40 provides an aesthetically pleasing, white appearance. Each of the filter segments is manufactured using known filter rod making machinery. The two segments are combined using known plug tube combining techniques (e.g., using a Mulfi from Hauni-Werke Korber & Co., K.G.), and are held together using circumscribing outer wrapping material 44 (e.g., paper plug wrap) so as to form the filter element 30.

The filter element 30 is attached to the tobacco rod 15 by tipping material 45 which circumscribes both the entire length of the filter element and an adjacent region of the tobacco rod. The inner surface of the tipping material 45 is fixedly secured to the outer surface of the outer plug wrap 44 and the outer surface of the wrapping material 25 of the tobacco rod, using a suitable adhesive. A ventilated or air diluted smoking article is provided with an air dilution means, such as a series of perforations 50, each of which extend through the tipping material and plug wrap.

Referring to FIGS. 1 and 2, one type of outer wrapping material 27 has a width w (shown in FIG. 2) which is equal to the circumference of the cigarette plus the lap zone of the glue line which ultimately results during cigarette manufacture. The preferred second wrapping material 27 includes a series of perforations 60 which extend in a linear fashion along the longitudinal length of thereof. Alternatively, other configurations, such as a random perforation pattern, can be provided. The size, number and relative positioning of the individual perforations 60 can vary depending upon the desired characteristics of the cigarette which has the wrapping material incorporated therein. The individual perforations are shown as enlarged in FIGS. 1 and 2.

Referring to FIG. 1A, smokable material 20 is contained in a first circumscribing inner wrapping material 25, and a second outer wrapping material 27 circumscribes the first wrapping material. The first wrapping material 25 is formed into a circular shape such that the ends 71, 72 of the sides thereof abut one another. The ends 71, 72 of wrapping material 25 can abut one another (as shown in FIG. 1A), nearly abut one another, or slightly overlap one another. The second wrapping material 27 includes a lap zone 73 including a suitable adhesive therebetween so as to form a secure outer wrapper. As such, the width of the inner wrapping material is less than that of the outer wrapping material. A cigarette rod having such a configuration can be provided by supplying paper wrappers from two bobbins on a suitably equipped cigarette making machine, positioning the inner wrapping material on top of the outer wrapping material, passing the two wrapping materials so positioned through the garniture region of the cigarette making machine, and forming the tobacco rod. Equipment for providing a cigarette in such a manner is described in U.S. patent application Ser. No. 609,975, filed Nov. 6, 1990, and U.S. patent application

Ser No. 756,023, filed Sep. 6, 1991, which are incorporated herein by reference. Other equipment for manufacturing a cigarette in such a manner will be apparent to the skilled artisan.

Referring to FIG. 1B, smokable material 20 is contained in a first circumscribing inner wrapping material 25, and a second outer wrapping material 27 circumscribes the first wrapping material. The first wrapping material 25 is formed into a circular shape such that a lap zone 74 including a suitable adhesive therebetween is formed. The second wrapping material includes a lap zone 76 including a suitable adhesive therebetween so as to form a secure outer wrapper. A cigarette rod having such a configuration can be provided by forming a cigarette rod using known techniques, and then wrapping the rod so formed with an outer wrapping material. Equipment for providing such a cigarette will be apparent to the skilled artisan.

Another preferred embodiment of a cigarette of the present invention is shown in FIG. 3. The cigarette 10 is generally similar to the cigarette described with reference to FIGS. 1, 1A, 1B and 2, except that the filter element 30 includes 3 filter segments which are aligned in an end-to-end relationship, preferably abutting one another. Such a filter element has a so-called "triple filter" configuration. Center filter segment 85, positioned between rod end filter segment 87 and mouthend segment 89, includes a filter material 91, such as particulate carbonaceous material, gathered carbon paper or cellulose acetate tow having carbonaceous particles dispersed therein. The filter element 30 can be a so-called "cavity filter" containing a segment of carbonaceous particles, but typically, the filter material 91 of the center segment is circumscribed by a wrapping material 93, such as paper plug wrap. The rod end and mouthend filter segments 87, 89 each include filter material 94, 95, respectively. The filter materials 94, 95 typically are materials such as gathered cellulose acetate web, plasticized cellulose acetate tow, gathered polypropylene web, gathered polyester web, or polypropylene tow. The filter materials of each of the rod end and mouth end filter segments can be the same as or different from one another. The filter materials 94, 95 each are circumscribed by wrapping material 96, 97, respectively. The three filter segments are held together using circumscribing outer wrapping material 44 so as to form the filter element 30

The smokable material employed in the manufacture of the tobacco rod can vary. For example, the smokable material of the cigarette can have the form of filler (e.g., tobacco cut filler). As used herein, the terms "filler" or "cut filler" are meant to include tobacco materials and other smokable materials which have a form suitable for use in the manufacture of tobacco rods for cigarettes. As such, filler can include smokable materials which are blended and are in a form ready for cigarette manufacture. The filler materials normally are employed in the form of strands or shreds as is common in conventional cigarette manufacture. For example, the cut filler material can be employed in the form of strands or shreds from sheet-like or "strip" materials which are cut into widths ranging from about 1/20 inch to about 1/60 inch, preferably from about 1/25 inch to about 1/35 inch. Generally, such strands or shreds have lengths which range from about 0.25 inch to about 3 inches.

Examples of suitable types of tobacco materials include flue-cured, Burley, Maryland or Oriental tobaccos, the rare or specialty tobaccos, and blends thereof. The tobacco material can be provided in the form of tobacco lamina; processed tobacco materials such as volume expanded or puffed tobacco, processed tobacco stems such as cut-rolled or cut-puffed stems, reconstituted tobacco materials; or blends thereof. Certain reconstituted tobacco materials are described in U.S. Pat. No. 4,987,906 to Young, et al.; in European Patent Application No. 419,733; and in U.S. patent application Ser. Nos. 416,332, filed Sep. 29, 1989 now U.S. Pat. No. 5,056,537; 647,329, filed Jan. 28, 1991; and 710,273, filed Jun. 4, 1991. Certain processed tobacco materials are described in U.S. Pat. No. 5,025,812 to Fagg, et al.; and U.S. patent application Ser. No. 484,587, filed Feb. 23, 1990 now U.S. Pat. No. 5,065,775. Certain blends are described in U.S. Pat. Nos. 4,924,888 to Perfetti, et al.; 4,942,888 to Montoya, et al.; and 4,998,541 to Perfetti, et al. Preferably, the smokable material or blend of smokable materials consists essentially of tobacco filler material or consists only of tobacco filler material.

Smokable materials can be cased and top dressed as is conventionally performed during various stages of cigarette manufacture. As such, the smokable material, and particularly tobacco filler material, can include casing and/or top dressing components. For example, blend components such as flavoring agents and humectants, as well as other forms of tobacco (e.g., tobacco extracts), can be applied to the smokable material, as is commonly performed when cigarettes are manufactured. See, Leffingwell, et al., *Tobacco Flavoring For Smoking Products* (1972). Suitable flavoring agents and forms of tobacco include vanillin, tobacco extracts such as tobacco essences and tobacco aroma oils, cocoa, licorice, menthol, and the like. Flavor modifying agents such as levulinic acid can be applied to the smokable material (e.g., in amounts ranging from about 0.01 to about 2 percent, normally from about 0.1 to about 1 percent, preferably about 0.2 to about 0.6 percent, based on the dry weight of the smokable material). Such components conveniently are applied to the smokable material as casing and top dressing components. See, U.S. Pat. No. 4,830,028 to Lawson, et al.

Typically, the tobacco rod has a length which ranges from about 35 mm to about 85 mm, preferably about 40 to about 70 mm; and a circumference of about 17 mm to about 27 mm, preferably about 22.5 mm to about 25 mm. Short cigarette rods (i.e., having lengths from about 35 mm to about 50 mm) can be employed, particularly when smokable blends having a relatively high packing density are employed.

The packing densities of the blend of smokable materials contained within the wrapping materials can vary. Typical packing densities for tobacco rods of cigarettes of the present invention range from about 150 to about 300 mg/cm^3. Normally, packing densities of the tobacco rods range from about 200 to about 280 mg/cm^3.

The second or outer wrapping material most preferably is a cigarette wrapping material having a low inherent air permeability value. By the term "inherent permeability" is meant the air flow porosity of the wrapping material itself. For example, such wrapping materials have inherent air permeabilities of less than about 15 CORESTA units, normally less than about 10 CORESTA units, generally less than about 8 CORESTA units, sometimes less than about 5 CORESTA units, often less than about 3 CORESTA units, and frequently less than about 1 CORESTA unit. Such wrapping materials include a cellulosic base web (e.g., provided from wood pulp and/or flax fibers) and inorganic filler mate-

rial (e.g. magnesium hydroxide filler and calcium carbonate particles) If desired, the cellulosic base web can include tobacco parts or pieces (e.g., tobacco stem parts), extracted tobacco parts or pieces (e.g., tobacco pulp) or bleached tobacco parts or pieces. If desired, tobacco extract can be incorporated into the outer wrapping material.

The second wrapping material preferably is processed in order to have a relatively high net permeability (e.g., a net permeability above about 40, and preferably above about 50 CORESTA units). By the term "net permeability" is meant the air flow porosity of the wrapping material as used in manufacturing the tobacco rod. Typically, the air permeability is provided to the wrapping material using micro laser, mechanical or electrostatic perforation techniques. During micro laser and electrostatic perforation operations, it is most desirable that care be taken to maintain the desired color and opacity of the paper. For example, it is most desirable to minimize or avoid an unsightly "browning" or singeing of the paper. For example, second wrapping materials having low inherent permeabilities can be perforated using conventional electrostatic perforating techniques (e.g., to provide individual perforations comparable in size to conventional electrostatically provided perforations) to obtain a wrapping material having a net porosity of from about 50 to about 225 CORESTA units, preferably from about 80 to about 180 CORESTA units; more preferably from about 90 to about 120 CORESTA units.

The sizes of the individual perforations which provide for the high net permeabilities to the outer wrapping materials generally are such that the perforations are larger than the pores which are present in the naturally occurring paper wrapping material (i.e., which provide the inherent permeability to the paper). For aesthetic purposes, the individual perforations preferably are small enough to not be unsightly. For example, the perforations are not particularly noticeable, and in most instances are barely visible to the naked eye.

Typical outer wrapping materials are paper wrapping materials which contain about 50 to about 75, preferably about 55 to about 70 weight percent cellulosic material; and about 25 to about 50, preferably about 30 to about 45 weight percent inorganic filler. Often desirable paper wrapping materials contain more than about 5, and frequently more than about 7 percent by weight of magnesium hydroxide filler. Preferred paper wrapping materials contain from about 8 to about 35 percent, often about 10 to about 30 percent, and sometimes about 20 to about 30 percent, by weight of magnesium hydroxide. Examples of suitable materials are described by U.S. Pat. Nos. 4,450,847 to Owens, 4,881,557 to Martin and 4,915,118 to Kaufman, et al. The preferred wrapping materials also contain other inorganic fillers, such as calcium carbonate. Preferred paper wrapping materials contain about 5 to about 35 percent, more often about 10 to about 20 percent, by weight of calcium carbonate. Other materials, such as magnesium oxide particles, calcium sulfate fibers, particles of carbonaceous materials, and the like, can be incorporated into the wrapping material. The preferred papers also contain flax fibers, wood pulp, or other cellulosic materials to provide a cellulosic base web Preferred papers containing magnesium hydroxide filler have relatively high basis weights Typical basis weights are at least about 30 g/m^2, often are greater than about 40 g/m^2, and frequently are greater than about 45 g/m^2. Typical basis weights do not exceed about 80 g/m^2.

A second paper wrapping material having magnesium hydroxide filler preferably includes at least one water soluble alkali metal salt. Examples of water soluble alkali metal salts include potassium malate, potassium acetate, potassium nitrate, potassium citrate, potassium chloride, potassium succinate, potassium propionate, potassium formate, and the like, as well as mixtures thereof. It is preferable that at least a portion of the alkali metal be provided in the form of a salt exhibiting a very low hygroscopic character. An example of such a salt is potassium chloride. The manner in which the water soluble alkali metal salt is incorporated into the second paper wrapping material can vary. The salt can be incorporated into the paper during the manufacturing process. Alternatively, the salt can be incorporated into the paper using size press techniques, printing techniques, painting techniques, or the like. Such techniques will be apparent to the skilled artisan. It is highly preferred that the salt be incorporated into the paper in an essentially uniform manner throughout the paper. The various water soluble salts can be incorporated into the paper simultaneously, or at different processing stages or after paper manufacture.

Although the amount of water soluble alkali metal salt incorporated into the second paper wrapping material having magnesium hydroxide filler can vary, the amount of such salt normally is such that the amount of that salt provides at least about 10 mg, and generally at least about 30 mg water soluble alkali metal ions per gram of dry base web. The amount of water soluble alkali metal salts incorporated into the paper normally is such that those salts provide at least about 35 mg, and frequently at least about 40 mg, water soluble alkali metal ions per gram of dry base web. The amount of water soluble alkali metal salts incorporated into the paper normally is such that those salts provide less than about 90 mg, and frequently less than about 80 mg, water soluble alkali metal ions per gram of dry base web. The level of potassium ions within the second paper wrapping material normally is significantly greater than the level of sodium ions within the paper. In particular, the weight ratio of potassium ions to sodium ions within the paper preferably is greater than about 100:1, preferably greater than about 150:1, more preferably greater than about 200:1.

The second paper wrapping material having magnesium hydroxide filler preferably has at least one organic acid or inorganic acid applied thereto in a non-disassociated form. The acid normally is applied to finished paper using size press or printing techniques. Examples of organic acids include malic, citric, levulinic, fumaric, oxalic and tartaric acids, as well as blends thereof. Examples of inorganic acids include hydrochloric, phosphoric, sulphuric and boric acids, as well as blends thereof. Mixtures of organic and inorganic acids can be employed. It is often preferable to apply the acid to the finished paper by dissolving or dispersing the acid in alcohol or water, and applying the resulting solution or dispersion to the paper. Typically, sufficient acid is applied to the paper to provide a paper having greater than about 0.2 percent, preferably greater than about 0.3 percent, more preferably greater than about 0.4 percent of that acid, based on the dry weight of that paper Typically, the amount of acid applied to the paper is less than about 6 percent, usually less than about 4 percent, based on the dry weight of that paper. Although the

acid is applied to the paper in a non-disassociated (i.e., acid) form, a certain amount of the acid can be present within the paper in a disassociated (i.e., salt) form. As used herein and only for purposes of the present invention, the term "non-disassociated" in referring to the acid is meant that the acid is not in a form of a salt (e.g., a sodium, potassium, calcium or magnesium salt). The acid can be incorporated into the second paper wrapping material together with the alkali metal salt. For example, potassium hydroxide can be contacted with a stoichiometric excess of malic acid in water, and the resulting solution of potassium malate and malic acid can be applied to the wrapping material using a size press. Preferred paper wrapping materials incorporate at least about 0.4, more preferably greater than about 1, and most preferably greater than about 2 weight percent malate ion (e.g., provided as potassium malate and malic acid).

The second paper wrapping material having magnesium hydroxide filler optionally can have at least one sugar applied thereto. Examples of sugars include sucrose, glucose, fructose, dextrose and maltose. The sugar normally is applied to the finished paper using size press or printing techniques. It is often preferable to apply the sugar to the finished paper by dissolving the sugar in an aqueous liquid (e.g., along with the previously described alkali metal salt), and applying the resulting solution to the paper. When employed, the sugar is applied to the paper in an amount up to about 12 percent, preferably about 0.5 to about 8 percent, more preferably about 1 to 5 percent, based on the dry weight of the paper.

Examples of suitable outer paper wrapping materials are available as Ecusta Experimental Paper Nos. TOD 05504, TOD 05405, TOD 05273, TOD 05275, TOD 05375, TOD 05759, TOD 05721, TOD 05560, TOD 05505, TOD 05386, TOD 05390, TOD 05422, TOD 05387, TOD 05551, TOD 05151, TOD 05365, TOD 05992, TOD 05962, TOD 05963, TOD 05969 and TOD 05943 from Ecusta Corp.

Another suitable second wrapping material is a cigarette paper consisting essentially of calcium carbonate and flax. Suitable second wrapping materials are available as P-2123-0101 and P-2123-0103 from Kimberly-Clark Corp. and as Reference No. TOD 03816 from Ecusta Corp. Also suitable are cigarette papers manufactured from wood pulp and inorganic fillers such as calcium carbonate. An example of such a paper is available as P-2540-21 from Kimberly-Clark Corp. Certain preferred second or outer wrapping materials include an amount of at least one polymeric film forming agent sufficient to provide a desirably low inherent permeability. For example, a sufficient amount of polymeric film forming agent can be applied to a paper wrapper having an air permeability of from about 10 to about 30 CORESTA units to provide a paper having an inherent air permeability of less than about 8 CORESTA units, sometimes less than about 5 CORESTA units, often less than about 3 CORESTA units, and frequently less than about 1 CORESTA unit. Similarly, a sufficient amount of an aqueous solution of a polymeric film forming agent can be applied to a paper wrapper having a relatively low air permeability (e.g., less than about 10 CORESTA units) to provide a paper having yet a lower inherent air permeability (e.g., less than about 5 CORESTA units, and frequently less than about 1 CORESTA unit). Examples of polymeric film forming agents are sodium carboxymethylcellulose and low viscosity ammonium alginate. One wrapping material is available as P-2540-83 from Kimberly-Clark Corp., which is a paper having a basis weight of about 32 g/m^2 and an initial permeability of about 6 CORESTA units to which 3.4 weight percent sodium carboxymethylcellulose has been applied to provide a final inherent permeability of about 0.7 CORESTA unit. Another wrapping material is available as P-2540-84 from Kimberly-Clark Corp.; which is a paper having a basis weight of about 31 g/m^2 and an initial permeability of about 17 CORESTA units to which 3.5 weight percent sodium carboxymethylcellulose is applied to provide a final inherent permeability of about 5.1 CORESTA units. Another wrapping material is available as P-2540-82 from Kimberly-Clark Corp.; which is a paper having a basis weight of about 32 g/m^2 and an initial permeability of about 6 CORESTA units to which 1 weight percent sodium carboxymethylcellulose is applied to provide a final inherent permeability of about 4 CORESTA units. Another wrapping material is available as P-2540-80 from Kimberly-Clark Corp.; which is a paper having a basis weight of about 32 g/m^2 and an initial porosity of about 6 CORESTA units to which 1.6 weight percent sodium carboxymethylcellulose is applied to provide a final inherent permeability of about 2.7 CORESTA units. Another wrapping material is available as P-2540-81 from Kimberly-Clark Corp.; which is a paper having a basis weight of about 32 g/m^2 and an initial permeability of about 6 CORESTA units to which 2.6 weight percent sodium carboxymethylcellulose is applied to provide a final inherent permeability of about 1.7 CORESTA units. Other wrapping materials having basis weights of about 30 g/m^2, air permeabilities of less than about 2 CORESTA units, having about 1 weight percent low viscosity ammonium alginate or sodium carboxymethyl- cellulose applied, and having about 4 to about 7 weight percent potassium citrate applied, are available as P-2831-60-1, P-2831-102, P-2831-140, P-2831-179, P-3122-23, P-3194-145 and P-3122-40 from Kimberly-Clark Corp. Another wrapping material is available as P-3122-4-1 from Kimberly-Clark Corp.; which is a paper having a basis weight of about 32 g/m^2 and an initial porosity of about 6 CORESTA units to which 1.1 weight percent sodium carboxymethylcellulose is applied to provide a final inherent permeability of about 1 CORESTA unit. Other wrapping materials are available as P-3122-40EP and from Kimberly-Clark Corp.

Such wrapping materials can include a burn chemical. Typically, the amount of burn chemical does not exceed about 10 percent; but usually is greater than about 0.25 percent, based on the dry weight of the wrapping material. Examples of burn chemicals are potassium citrate, sodium citrate, potassium acetate, sodium succinate, potassium nitrate and potassium succinate. Methods of application of such salts to the wrapping material will be apparent to the skilled artisan. If desired, sizing agents and wet strength agents, such as Hercon 70 and Aquapel from Hercules, Inc., can be incorporated into the paper wrapping materials. If desired, the various burn additives and polymeric agents can be applied to the wrapping material in separate applications or in one application as a mixture. The wrapping material can be absent of Verge lines or that wrapping material can have Verge lines. Preferably, such paper wrapping materials are perforated (e.g., electrostatically perforated) to provide the desired net permeability. For example, the wrapping material can

be perforated (e.g., electrostatically perforated) so as to exhibit a net porosity of from about 30 to about 225 CORESTA units, preferably from abut 50 to abut 180 CORESTA units.

If desired, flavoring agents and/or flavor and aroma precursors (e.g., vanillin glucoside and/or ethyl vanillin glucoside) can be incorporated into the second paper wrapping material. See, U.S. Pat. No. 4,941,486 to Dube, et al., which is incorporated herein by reference.

The first or inner wrapping material most preferably comprises tobacco material. A certain amount of inorganic filler material (e.g., calcium carbonate) and/or a water soluble salt (e.g., potassium citrate) most preferably is incorporated into the inner wrapping material. The inner wrapping material also can include a carbonaceous material. The inherent permeability of the inner wrapping material can vary, but usually is higher than the inherent permeability of the outer wrapping material, and frequently is quite high relative to the outer wrapping material. Normally, the ultimate inherent permeability provided by the combined wrapping materials is slightly less than that inherent permeability of the outer wrapping material; however, effects of the inner wrapping material towards lowering the ultimate inherent permeability of the combined wrapping materials are less in instances in which the differences between the inherent permeabilities of the inner and outer wrapping materials are relatively great. Generally, the inherent permeability of the inner wrapping material is above about 10 CORESTA units, often above about 50 CORESTA units, and frequently is above about 100 CORESTA units, although the permeability of that wrapping material can approach 1,000 CORESTA units. The inner wrapping material can be perforated (e.g., electrostatically perforated) to provide the desired net permeability.

Various inner wrapping materials can be employed. One wrapping material is available as P-2540-94-A from Kimberly-Clark Corp.; which is a paper containing about 29 weight percent particles of activated charcoal provided from coconut hulls and about 71 weight percent tobacco parts, and having a permeability of about 250 CORESTA units. Another wrapping material is available as P-2540-94-C from Kimberly-Clark Corp.; which is a paper containing about 40 weight percent particles of activated charcoal provided from coconut hulls and about 60 weight percent tobacco parts, and having a permeability of about 350 CORESTA units. Another wrapping material is available as P-2540-94-D from Kimberly-Clark Corp.; which is a paper containing about 50 weight percent particles of activated charcoal provided from coconut hulls and about 50 weight percent tobacco parts, and having a permeability of about 380 CORESTA units. Another wrapping material is available as P-2540-136-C from Kimberly-Clark Corp.; which is a paper made from wood pulp, flue-cured and Burley tobacco stems and carbonized hardwood particles, and has a basis weight of about 47 g/m^2 and an inherent permeability of about 14 CORESTA units. Another wrapping material is available as P-3122-4-4 from Kimberly-Clark Corp.; which is a paper made from about 20 weight percent wood pulp, about 30 weight percent Turkish tobacco strip, about 30 weight percent "American blend" in cut filler form and about 20 weight percent calcium carbonate particles, and is electrostatically perforated to a net permeability of about 150 CORESTA units. Another wrapping material is available as P-2531-189-AA4 from Kimberly-Clark Corp.; which is a paper made from 20 weight percent wood pulp, about 30 weight percent Turkish tobacco strip, about 30 weight percent "American blend" in cut filler form and about 20 weight percent calcium carbonate particles, and has a basis weight of about 60 g/m^2 and an inherent permeability of about 125 CORESTA units. Another wrapping is available as P-3284-11 from Kimberly-Clark Corp., which is a paper made from 25 weight percent wood pulp, about 66 weight percent Turkish tobacco strip and about 9 weight percent calcium carbonate particles, and has a basis weight of about 60 g/m^2 and an inherent permeability of about 50 CORESTA units. Other wrapping materials include carbonaceous material, wood pulp and tobacco stem parts; have porosities between about 60 and about 150 CORESTA units; have basis weights between about 45 g/m^2 and about 70 g/m^2; and are available as P-2540-107-A, P-2540-107-B, P-2540-107-C and P-2540-107-D from Kimberly-Clark Corp. Other materials are available as P-2249-115, P-2674-157, P-2540-155, P-2540-136-D, P-2540-136-E, P-2540-152, P-2540-150, P-2540-157, P-2540-151, P-2540-156, P-2831-197-A10, P-2540-94-A, P-144-KC-G, P-144-RB, P-144-KCL, P-144-SN20, P-144-BHC, P-2674-157-A5116, P-2674-157-A5116, P-2831-130, P-2831-22-1, P-2831-23-3, P-1976-25-1, P-1976-25-2, P-2540-191, P-2540-192, P-2540-193, P-2540-194, P-2540-195, P-2540-196, P-1976-25-3, P-2831-189-B1-6606, P-2831-189-B2-6608 and P-2831-189-B3-6609 from Kimberly-Clark Corp. Although less preferred from a manufacturing standpoint, the inner wrap also can be a reconstituted tobacco material of the type described in U.S. Pat. Nos. 4,962,774 ,o Thomasson, et al. and 4,987,906 to Young, et al. and U.S. patent application Ser. No. 710,273, filed Jun. 4, 1991.

The most preferred inner wrapping materials are tobacco containing papers. Tobacco containing papers are made from tobacco parts (e.g., tobacco stems, tobacco fines, pieces of tobacco stems, tobacco dust, tobacco cut filler, tobacco strip, tobacco leaf, processed tobacco stems, tobacco scrap, extracted tobacco pulp, and/or tobacco extracts). Preferred tobacco containing papers include the cellulosic portion of the tobacco material, and also can include one or more tobacco extracts. As such, preferred tobacco containing papers incorporate tobacco as a cellulosic component. The inner wrapping materials also can have cellulosic materials (e.g., wood pulp), as well as additive water soluble salts and additive inorganic fillers (e.g., calcium carbonate and/or magnesium hydroxide) incorporated therein. Methods for manufacturing such papers will be apparent to the skilled artisan.

Certain preferred tobacco containing inner wrapping materials include more than about 25 weight percent, usually more than about 50 weight percent, and preferably about 50 to about 85 weight percent tobacco. Certain preferred wrapping materials also can include up to about 50 weight percent, and preferably about 20 to about 70 weight percent cellulosic material. Examples of useful cellulosic materials include softwood pulp, hardwood pulp and flax fibers. Such wrapping materials also can include up to about 35 weight percent, preferably up to about 25 weight percent, and more preferably up to about 20 weight percent inorganic filler additive. Examples of inorganic filler materials include calcium carbonate particles, calcium sulfate fibers, particles of calcium sulfate, magnesium oxide, magnesium hydroxide, and agglomerated filler materials described in Eu-

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ropean Patent Application No. 419,733. Certain preferred inner wrapping materials include greater than about 5 weight percent magnesium oxide and/or magnesium hydroxide filler. Such wrapping materials also can include up to about 10 weight percent, preferably up to about 6 weight percent, and most preferably about 1 to about 3 weight percent of at least one additive salt, such as a water soluble salt. Such an additive salt can act as a burn chemical. Examples of such additive salts include inorganic salts (e.g., potassium chloride and potassium nitrate) and salts having inorganic cations (e.g., potassium citrate, potassium acetate, potassium propionate and potassium succinate). Such wrapping materials can be perforated (e.g., electrostatically perforated), if desired, to provide wrapping materials having net porosities greater than the inherent porosities thereof.

Certain preferred inner wrapping materials include about 65 to about 85 weight parts tobacco, and about 15 to about 35 weight parts softwood pulp. Such tobacco containing papers can have high or low air permeability, high or low levels of additive salt burn chemical (e.g., potassium succinate or potassium citrate), high or low levels of inorganic filler material, and can be perforated (e.g., electrostatically perforated), if desired.

The inner wrapping material normally includes a burn chemical (e.g., at least one water soluble salt additive). Typically, the amount of burn chemical does not exceed about 10 percent; but usually is greater than about 0.25 percent, based on the dry weight of the wrapping material. Certain wrapping materials can have very low levels, or be absent, of added burn chemical, particularly if that material includes a relatively high level of an aqueous tobacco extract therein. In particular, wrapping materials having an aqueous tobacco extract content of greater than about 25 percent, usually greater than about 30 percent, based on the dry weight of the wrapping material, can be employed in the absence of any added burn chemical.

The optional carbonaceous material of the inner wrap can vary. The carbonaceous material is combustible under those conditions (i.e., temperatures) experienced during the period that the cigarette is smoked. The carbonaceous material most preferably is derived from natural cellulosic materials. Certain natural cellulosic materials have a high cellulose content (i.e., a cellulose content above about 80 weight percent), and often a high alpha-cellulose content (i.e., an alpha-cellulose content above about 80 weight percent). Examples of natural cellulosic materials which can be pyrolyzed to provide combustible carbonaceous materials include tobacco materials, softwood pulp, hardwood pulp, coconut hulls, kapok fibers, cotton fibers, cotton linters, and the like, as well as combinations thereof. Combustible carbonaceous materials typically are provided by pyrolyzing a natural cellulosic material under inert (e.g., nitrogen) atmosphere at temperatures between about 600° C. and about 1,200° C., preferably between about 650° C. and about 850° C. Preferred carbonaceous materials include at least about 80 weight percent carbon, normally include about 85 weight percent and about 95 weight percent carbon. Exemplary carbonaceous materials are set forth in European Patent Application Nos. 236,992 and 419,733; and U.S. patent application Ser. No. 378,551, filed Jul. 11, 1980 now U.S. Pat. No. 4,991,596, which are incorporated herein by reference

The amount of the optional carbonaceous material within the inner wrapping material can vary. Typical inner paper wrapping materials have relatively high levels of carbonaceous material and/or incorporate carbonaceous materials formed under relatively high pyrolysis temperatures when outer wrapping materials are of relatively low porosity. Normally, the amount of the optional carbonaceous material within the inner wrapping material is greater than about 5 percent, usually greater than about 10 percent, generally greater than about 20 percent, often greater than about 30 percent, and frequently greater than about 40 percent, based on the weight thereof. The form of the carbonaceous material can vary; but is typically in powder or particulate form of about 5 microns to about 20 microns in diameter.

The amount of the optional carbonaceous material within the inner wrapping material relative to the total weight of the tobacco rod can vary. Often, the inner wrap comprises greater than about 2, often about 2 to about 8, and frequently about 3 to about 7 percent carbonaceous material therewithin, based on the total weight of the tobacco rod. Typically, when the outer wrapping material has a porosity which is extremely low (i.e., about 2 CORESTA units or less), the inner wrapping material often can have a relatively high level of the optional carbonaceous material therewithin (i.e., about 5 percent or more, based on the weight of the tobacco rod).

Certain flavoring agents can be incorporated into or otherwise carried by the inner wrapping material. In particular, the optional carbonaceous material of the inner wrapping material can act as a particularly good substrate for certain flavoring agents. Examples of suitable flavoring agents include menthol, vanillin, and the like. Suitable flavoring agents are set forth in Leffingwell, et al., *Tobacco Flavoring For Smoking Products* (1972). The carbonaceous material is a particularly good substrate for volatile flavoring agents. If desired, flavor and aroma precursors can be incorporated into the inner wrapping material.

Exemplary tobacco rods having two layers of wrapping material circumscribing a charge of tobacco cut filler are described in Examples 1 through 32 of U.S. patent application Ser. No. 661,747, filed Feb. 27, 1991, which is incorporated herein by reference.

Typically, the filter element has a length which ranges from about 15 mm to about 40 mm, preferably about 20 mm to about 35; and a circumference of about 17 mm to about 27 mm, preferably about 22 mm to about 25 mm. The filter element can have a wide range of filtration efficiencies. Typically, the filter segment containing carbonaceous material has a low filtration efficiency for particulate matter.

For filter elements having 2 filter segments (e.g., as described with reference to FIG. 1), the rod end filter segment typically has a length of about 20 to about 60 percent of the total length of filter element, while the mouthend filter segment typically has a length of about 40 to about 80 percent of the total length of the filter element. For filter elements having 3 filter segments (e.g., as described with reference to FIG. 3), the rod end filter segment typically has a length of about 15 to about 30 percent of the total length of the filter element, the mouthend filter segment typically has a length of about 15 to about 30 percent of the total length of the filter element, and the center filter segment typically has a

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length of about 30 to about 60 percent of the total length of the filter element.

The carbonaceous material which is incorporated into the filter element can vary. Most preferred carbonaceous materials are highly activated. Carbonaceous materials most useful herein have a high carbon content; consist primarily of carbon; and preferably have a carbon content above about 80 weight percent, and more preferably above about 90 weight percent. Preferred carbonaceous materials are provided by carbonizing or pyrolyzing tobacco material, softwood pulp, hardwood pulp, coconut hulls, kapok fibers, cotton fibers, cotton linters, and the like. Examples of suitable carbonaceous materials are activated coconut hull based carbons available from Calgon Corp. as PCB 12x30 and GRC-11 12x30. Examples of suitable carbonaceous materials are coal based carbons available from Calgon Corp. as S-Sorb 12% Cu 12x30; BPL 12x30; CRC-11F 12x30; FCA 12x30, Cu, CrO_3; and SGL. Examples of suitable carbonaceous materials are wood based carbons available from Westvaco as WV-B, SA-20 and BSA-20. Other carbonaceous materials are available from Calgon Corp. as HMC; ASC/GR-1 12x30 Cu, Ag, CrO_3; and SC II; and another carbonaceous material includes Witco Carbon No. 637. Other carbonaceous materials are described in U.S. patent application Ser. No. 569,325, filed Aug. 17, 1990; U.S. Pat. Nos. 4,771,795 to White, et al. and 5,027,837 to Clearman, et al; and European Patent Application Nos. 236,922; 419,733 and 419,981. Certain carbonaceous materials can be impregnated with substances such as propylene glycol, potassium bicarbonate, tobacco extracts, polyethyleneimine, manganese dioxide, eugenol, and 4-ketononanoic acid. The size of the individual carbon particles or granules can vary, depending upon the design of the filter element. Typically, large size particles have a U.S. mesh size of about $-6/+16$; medium size particles have a U.S. mesh size of about $-12/+30$; and small size particles have U.S. mesh sizes of about $-20/+50$ and $-30/-70$. Carbonaceous materials also can have a monolithic form, a bonded granular form, a fibrous form, or an agglomerated form; or be combined with molecular sieves, alumina particles or ion exchange resin particles.

The carbon for the filter segment of the filter element can be provided within a paper, and that paper can be shredded, gathered, or corrugated and gathered to form the filter segment. Typically, for a filter element having a circumference of about 22 mm to about 25 mm, the carbon-containing paper which is gathered to form a filter segment has a width of about 3.5 inches to about 11 inches, and usually about 5 inches to about 8.5 inches. Shredded paper filter segments can be provided as described in U.S. Pat. No. 5,025,814 to Raker. Gathered paper filter segments can be provided (i) using the apparatus described in U.S. Pat. No. 4,807,809 to Pryor, et al.; (ii) using the apparatus generally as described by Keith, et al. in U.S. Pat. No. 4,283,186 at col. 4, line 50 through col. 5, line 6; or (iii) using a rod making unit available as CU-10 or CU20S from Decoufle s.a.r.b., together with a KDF-2 rod making apparatus from Hauni-Werke Korber & Co., K. G. Filter segments can be provided by simultaneously gathering a tobacco-containing paper web and a carbon-containing paper web, so as to provide a segment having two types of gathered papers. Filter segments also can be provided by simultaneously gathering a carbon-containing paper web and a web of thermoplastic material (e.g., as described in U.S. patent application Ser. Nos. 414,833, filed Sep. 29, 1989 now U.S. Pat. No. 5,074,321; 606,287, filed Nov. 6, 1990, and 621,499, filed Dec. 7, 1990 now U.S. Pat. No. 5,105,834), so as to provide a segment having two types of gathered Carbon-containing filter segments then can be plug tube combined with one or more other filter segments (e.g., with a segment of gathered polypropylene web, gathered cellulose acetate web, or cellulose acetate tow) using known plug tube combination techniques.

Exemplary carbon-containing papers are available as P-144-BSHC, P-144-BAC and P-144-BHC from Kimberly-Clark Corp. Other carbon-containing papers are described in European Patent Application No. 342,538, which is incorporated herein by reference. Other carbon-containing papers are available from Kimberly-Clark Corp. as P-2674-12-12, P-2674-13-17, P-2674-14-24, P-2674-11-3, P-2674-11-7, P-3122-6-8, P-3122 -6-8, P-3122-6-6, P-3122-6-5, P-3122-6-12 and P-3001-72-1. Other carbon-containing papers will be apparent to the skilled artisan. For example, carbon particles can be embedded in a paper substrate and employed as a filter material for a filter segment.

Carbon particles or granules can be dispersed within filter material, such as cellulose acetate tow. The amount of carbonaceous material dispersed within a particular filter material of a filter element can vary. However, each filter element typically includes about 10 mg to about 130 mg, usually about 25 mg to about 100 mg, and frequently about 40 mg to about 75 mg of carbonaceous material. One preferred filter element includes a segment containing about 50 mg of carbonaceous powder having an average particle size of about 40 microns in diameter.

Other filter designs can be employed. For example, the carbonaceous materials can be employed in the form of loose granules. A so-called "cavity filter" of 27 mm length has a 12 mm segment of cellulose acetate tow (8 denier per filament/40,000 total denier), a 12 mm segment of gathered carbon-containing paper available as P-144-BAC from Kimberly-Clark Corp. and a 3 mm cavity between the two segments containing 60 mg of PCB carbon from Calgon Corp. of $+12/-30$ mesh size. Another filter element includes carbon threads and is available as ACT from FIL International, Ltd. Another filter element has a carbon-containing segment provided by inserting about 60 mg of $-12/+30$ carbon particles into the longitudinal passageway of a highly plasticized cellulose acetate tube. Other filter elements can include segments containing carbonaceous materials and segments such as those described in U.S. patent application Nos. 414,833 filed Sep. 29, 1989 now U.S. Pat. No. 5,074,321; 606,287 filed Nov. 6, 1990 now U.S. Pat. No. 5,105,834; and 621,499, filed Dec. 7, 1990.

The so-called "dual segment charcoal filter elements" can be employed. One 27 mm filter element includes a 7 mm black-dyed cellulose acetate tow segment impregnated with about 32.5 mg activated carbon particles of $-30/-70$ mesh size, and a 20 mm plasticized cellulose acetate tow segment, which filter element is available as SCS IV Dual Solid Charcoal Filter from American Filtrona Corp. One 31 mm filter element includes an 11 mm black-dyed cellulose acetate tow segment impregnated with about 32.5 mg of charcoal carbon particles of $-30/+70$ mesh size, and a 20 mm plasticized cellulose acetate tow segment, which filter element is available as SCS IV Dual Solid Charcoal Filter from American Filtrona Corp. One 31 mm filter element includes an

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18 mm cellulose acetate (5.0 denier per filament/35,000 total denier) segment impregnated with 46 mg of activated carbon of −30/+70 mesh size and a 13 mm segment of plasticized cellulose acetate tow (3.0 denier per filament/35,000 total denier), which is available as Dual Solid Charcoal Filter from Baumgartner. One 21 mm filter element includes a 10 mm cellulose acetate tow (3.3 denier/per filament/37,000 total denier) segment impregnated with about 46 mg activated carbon particles, and an 11 mm segment of cellulose acetate tow (2.5 denier per filament/37,000 total denier), which is available as Dual Segment Charcoal Filter from FIL International, Ltd.

The so-called "triple filter charcoal filter elements" can be employed. One 21 mm filter element includes 2 segments of cellulose acetate tow (2.5 denier per filament/37,000 total denier) of 5.5 mm length, and a center segment of 10 mm length comprising cellulose acetate tow (3.3 denier per filament/37,000 total denier) impregnated with 46 mg of activated carbon particles, which is available as Triple Solid Charcoal Filter from FIL International, Ltd. One 21 mm filter element includes an 11 mm segment of cellulose acetate tow, a 6 mm segment of cellulose acetate tow, and a cavity of 4 mm length between the two segments filled with 63 mg of charcoal particles, which is available as Triple Cavity Filter from Baumgartner. One 21 mm filter element includes a 10 mm segment of cellulose acetate tow, a 6 mm segment of cellulose acetate tow, and a cavity of 5 mm length between the two segments filled with 58 mg of charcoal particles, which is available as Triple Cavity Filter from FIL International, Ltd.

Typically, the tipping material circumscribes the filter element and an adjacent region of the tobacco rod such that the tipping material extends about 3 mm to about 6 mm along the length of the tobacco rod. Typically, the tipping material is a conventional paper tipping material and is adhesively secured to the filter element and the adjacent region of the tobacco rod. The tipping material can have a permeability which can vary. For example, the tipping material can be essentially air impermeable, air permeable, or be treated (e.g., by mechanical or laser perforation techniques) so as to have a region of perforations, openings or vents thereby providing a means for providing air dilution to the cigarette. The total surface area of the perforations and the positioning of the perforations along the periphery of the cigarette can be varied in order to control the performance characteristics of the cigarette.

For air diluted or ventilated cigarettes of this invention, the amount of air dilution can vary. Often, the amount of air dilution for an air diluted cigarette is greater than about 10 percent, and frequently greater than about 25 percent. The upper limit of air dilution for a cigarette typically is less than about 75 percent, more frequently less than about 65 percent.

Cigarettes of the present invention exhibit a desirably high resistance to draw. For example, cigarettes of this invention exhibit a pressure drop of between about 50 and about 200 mm water pressure drop at 17.5 cc/sec. air flow. Typically, pressure drop values of cigarettes are measured using a Filtrona Filter Test Station (CTS Series) available from Filtrona Instruments and Automation Ltd. Cigarettes of this invention preferably exhibit resistance to draw values of about 70 to about 180, more preferably about 80 to about 150 water pressure drop at 17.5 cc/sec. air flow.

Cigarettes of the present invention, when smoked, generally yield less than about 20 mg, preferably less than about 10 mg of sidestream "tar" per cigarette, as determined using the apparatus and techniques described by Proctor, et al., *Analyst*, Vol. 113, p. 1509 (1988). Such cigarettes normally provide more than about 6 puffs, preferably more than about 8 puffs per cigarette when smoked under FTC conditions. FTC conditions consist of 35 ml puffs of 2 second duration separated by 58 seconds of smolder. Normally, cigarettes of the present invention provide less than about 15 puffs, and often less than about 12 puffs, when smoked under FTC conditions. Normally, cigarettes of the present invention yield less than about 2 mg, preferably less than about 1.5 mg, and most preferably less than about 1 mg of sidestream "tar" per 1 minute puff cycle period, when smoked under FTC conditions.

Cigarettes of the present invention, when smoked, yield ash and firecone which are acceptable. The ash is not overly dark in color, is not easily dislodged from the cigarette, and is not flaky. The firecone is of acceptable length, is not overly cohesive, and is not overly fragile (i.e., maintains its integrity).

Cigarettes of the present invention exhibit a tendency to maintain smolder under static burning conditions (i.e., without puffing after the lighting puff). Much preferred cigarettes maintain smolder for at least about 3 minutes, more preferably at least about 5 minutes, and often at least about 7 minutes, without self-extinguishing. Preferred cigarettes are such that at least about one third of the burnable length of the tobacco rod, often at least about one half of the burnable length of the tobacco rod, and frequently the total burnable length of the tobacco rod is consumed during static burning conditions without self-extinguishing.

Cigarettes of the present invention burn at an acceptable rate during smoking, particularly under free smolder (i.e., static burning) conditions. Typical cigarettes of the present invention, and particularly those cigarettes having a circumference of about 24 mm to about 25 mm, exhibit a static tobacco rod linear burn rate of less than about 5 mm/min., and frequently between about 1.5 mm/min. and about 4 mm/min.

Cigarettes of the present invention generally provide FTC "tar" yields in the range from about 2 to about 14 mg/cigarette, although other "tar" yields are possible. Typical FTC "tar" to FTC carbon monoxide ratios for such cigarettes are less than about 1.8, and sometimes are less than about 1.6. Cigarettes of the present invention exhibit desirable organoleptic properties. Cigarettes having carbonaceous materials within the filter element preferably exhibit a smooth smoking character, and provide less harsh and less bitter attributes than comparable cigarettes not having such a filter element. Preferred filter elements assist in reducing the gas phase components of cigarette smoke that provide a harsh and bitter character to the flavor of such smoke.

The following examples are provided in order to further illustrate the invention but should not be construed as limiting the scope thereof. Unless otherwise noted, all parts and percentages are by weight.

EXAMPLE 1

Cigarettes substantially as shown in FIG. 1 are prepared as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm, and include a tobacco rod having a length of 57 mm and a filter element

having a length of about 27 mm. Each filter element includes a filter segment of gathered carbon paper and a filter segment of cellulose acetate tow. The first filter segment has a length of about 12 mm, and includes a gathered carbon paper available as P-144-BHC from Kimberly-Clark Corp. circumscribed by Reference No. 646 nonporous paper plug wrap from Kimberly-Clark Corp. The carbon paper is a carbon/tobacco paper containing about 17 percent PCB carbon of about 40 micron diameter. The first filter segment is provided by gathering an 8.5 inch width web of carbon paper as described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor, et al. The second filter segment has a length of about 15 mm, and includes triacetin plasticized cellulose acetate tow. The cellulose acetate tow circumscribed by nonporous paper plug wrap. The tow item is 2.1 denier per filament/48,000 total denier. Each first and second filter segment are attached together in an end-to-end relationship using a circumscribing nonporous plug wrap to provide a filter element. Each filter element is attached to each tobacco rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and about a 4 mm length of the tobacco rod in the region adjacent the filter element. The filter elements are ventilated to about 55 percent air dilution by providing a ring of mechanical perforation around the paper wrapping materials of the filter element about 13 mm from the extreme mouthend of the cigarette.

The smokable blend consists of tobacco material which has been cased with a casing mixture. The tobacco material has flue-cured, Burley and Oriental tobaccos as well as reconstituted tobacco from a paper-making process, and volume expanded flue-cured and Burley tobaccos. The blend of tobacco materials is cased using a mixture of glycerin, water and flavors. The blend is in the form of strands or shreds cut at about 25 cuts per inch (i.e., in cut filler form) and is equilibrated to a moisture level of about 12.5 percent. Each cigarette rod includes about 650 mg tobacco material.

The second or outer cigarette paper wrap is a 70 to 75 parts wood pulp and 25 to 30 parts calcium carbonate paper available as P-3122-40EP from Kimberly-Clark Corp. The paper wrap exhibits a net air permeability of about 55 CORESTA units provided by electrostatic perforation, and a basis weight of about 35.5 g/m^2. The paper wrap includes about 1.3 percent ammonium alginate, about 0.4 percent Hercon 70 from Hercules Inc. and about 4.4 percent potassium citrate applied thereto, and the paper exhibits an inherent permeability (i.e., a porosity prior to electrostatic perforation) of about 1 CORESTA unit.

The first or inner cigarette paper wrap is available as P-3284-11 from Kimberly-Clark Corp. The paper wrap includes tobacco parts, wood pulp and calcium carbonate particles. The inner paper wrap is absent of added burn chemical in the form of added water soluble salt. The paper is light brown in color, has a somewhat rough surface texture, and exhibits an inherent permeability of about 50 CORESTA units.

The tobacco rod is such that the inner wrap circumscribes the smokable blend and the outer wrap circumscribes the inner wrap. The inner and outer wraps directly contact one another (i.e., the inner surface of the outer wrap contacts the outer surface of the inner wrap).

The cigarettes are employed by burning the tobacco rod such that the blend of smokable material within the paper wrapper burns to yield smoke. When employed, such cigarettes yield very low levels of visible sidestream smoke and sustains smolder under static burning conditions after the lighting puff such that the total burnable length of the tobacco rod is consumed (i.e., the cigarette does not self-extinguish).

EXAMPLE 2

Cigarettes are provided as described in Example 1, except that the filter element is replaced with a filter element available as TSS 4035 from FIL International, Ltd. The cigarette is air diluted about 50 percent.

EXAMPLE 3

Cigarettes are provided as described in Example 1, except that the filter element is replaced with a filter element available as TSS 4036 from FIL International, Ltd. The cigarette is air diluted about 50 percent.

EXAMPLE 4

Cigarettes are provided as described in Example 1, except that the filter element is replaced with a filter element available as TSS 4054 from FIL International, Ltd. The cigarette is air diluted about 50 percent.

EXAMPLE 5

Cigarettes are provided as described in Example 1. However, the outer paper wrap of the tobacco rod is available as TOD 05504 from Ecusta Corp.; the inner wrap of the tobacco rod is available as P-2540-195 from Kimberly-Clark Corp., and the cigarette is air diluted to an air dilution level of about 50 percent.

The outer paper wrap is a heavy weight sheet, low visible sidestream paper. The base sheet contains about 15 percent calcium carbonate, about 25 percent magnesium hydroxide and about 60 percent flax fiber. The paper has an inherent permeability of about 10 CORESTA units and a basis weight of about 48 g/m^2. The paper has an aqueous solution including 2 percent malic acid and 12 percent potassium chloride incorporated therein using a size press. The paper includes about 45 mg potassium ions per gram of dry base sheet and about 1.3 percent malate ion analyzed in the paper (i.e., added to the paper as malic acid). The level of potassium ions in the paper is significantly greater than the level of sodium ions in the paper. The paper is electrostatically perforated so as to yield a net porosity of about 110 CORESTA units.

EXAMPLE 6

Cigarettes are provided as described in Example 5. However, the inner wrap of the tobacco rod is available as P-2540-194 from Kimberly-Clark Corp.; the first filter segment is provided by gathering a carbon paper web 8.5 inches wide and available as P-144-BSHC from Kimberly-Clark Corp., and the second filter segment includes plasticized cellulose acetate tow (2.7 denier per filament/48,000 total denier). The cigarette is air diluted about 50 percent.

EXAMPLE 7

Cigarettes are provided as described in Example 4. However, the first filter segment is provided by gathering a carbon paper web 8.5 inches wide available as P-144-50AC from Kimberly-Clark Corp

EXAMPLE 8

Cigarettes substantially as described in Example 1 are provided, except that the second or outer paper wrap is available as TOD 05759 from Ecusta Corp., and the first or inner wrap is available as P-2831-189-AA4 from Kimberly-Clark Corp. The inner wrap is not electrostatically perforated, and is absent of added burn chemical in the form of added water soluble salt.

The second or outer paper wrap is a heavy weight sheet, low visible sidestream paper. The base sheet contains about 30 percent calcium carbonate, about 8 percent magnesium hydroxide and about 62 percent flax fiber. The paper has an inherent permeability of about 10 CORESTA units and a basis weight of about 48 g/m^2. The paper has an aqueous solution including 2 percent malic acid, 6 percent potassium malate, 6 percent potassium chloride and 2.5 percent of an additive package available as DY 05012 from Quest International incorporated therein using a size press. The paper includes about 39 mg potassium ions per gram of dry base sheet and about 3.8 percent malate ion analyzed in the paper (i.e., added to the paper as potassium malate and malic acid). The paper is electrostatically perforated so as to yield a net porosity of about 110 CORESTA units.

EXAMPLE 9

Cigarettes substantially as shown in FIG. 1 are prepared as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm, and include a tobacco rod having a length of about 63 mm and a filter element having a length of about 21 mm. Each filter element includes about 46 mg carbon particles and is available as Dual Solid Charcoal Filter from FIL International, Ltd. The length of the first filter segment is about 10 mm, and the length of the second filter segment is about 11 mm.

The outer wrap of the tobacco rod is available as TOD 05992 from Ecusta Corp., and the inner wrap of the tobacco rod is available as P-3284-11 from Kimberly-Clark Corp.

The smokable material is an "American blend" of the type described in Example 1. Each cigarette rod includes about 720 mg tobacco material.

The cigarette is air diluted about 50 percent by providing a ring of perforations 13 mm from the extreme mouthend of the cigarette.

EXAMPLE 10

Cigarettes are provided as described in Example 9. However, the outer paper wrap of the tobacco rod is a paper available as TOD 05504 from Ecusta Corp. and the inner paper wrap of the tobacco rod is available as P-2540-195 from Kimberly-Clark Corp. The cigarette is air diluted about 50 percent.

EXAMPLE 11

Cigarettes substantially as shown in FIG. 3 are provided as described in Example 9. However, the filter element is available as Triple Solid Filter from FIL International, Ltd. The cigarette is air diluted about 50 percent by providing a ring of perforations 13 mm from the extreme mouthend of the cigarette.

EXAMPLE 12

Cigarettes substantially as shown in FIG. 3 are provided as described in Example 9. However, the outer wrap of the tobacco rod is available as TOD 05504 from Ecusta Corp., the inner paper wrap of the tobacco rod is available as P-2540-195 from Kimberly-Clark Corp., and the filter element is available as Triple Solid filter from FIL International, Ltd. The cigarette is air diluted about 50 percent by providing a ring of perforations 13 mm from the extreme mouthend of the cigarette.

EXAMPLE 13

Cigarettes substantially as shown in FIG. 3 are prepared as follows:

The cigarettes each have a length of about 99 mm and a circumference of about 24.75 mm, and include a tobacco rod having a length of abut 68 mm and a filter element having a length of about 31 mm. Each filter element includes about 50 mg highly activated coconut hull carbon particles dispersed in an 11 mm long segment of cellulose acetate tow. The filter element is available as TSS 4037 from FIL International, Ltd.

The outer wrap of the tobacco rod is available as TOD 05992 from Ecusta Corp. The inner wrap of the tobacco rod is available as P-3284-11 from Kimberly-Clark Corp.

The smokable material is an "American blend" of the type described in Example 1. Each cigarette rod includes about 910 mg tobacco material.

The cigarette is air diluted about 50 percent by providing a ring of perforations about 17 mm from the extreme mouthend of the cigarette.

EXAMPLE 14

Cigarettes are provided as described in Example 13. However, the outer wrap of the tobacco rod is available as P-3122-40EP from Kimberly-Clark Corp. The cigarette is air diluted about 55 percent by providing a ring of perforations about 17 mm from the extreme mouthend of the cigarette.

EXAMPLE 15

Cigarettes substantially as shown in FIG. 3 are prepared as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.7 mm. The tobacco rod has a length of about 57 mm, and the filter element has a length of about 27 mm. Each filter element includes a first 15 mm segment of gathered carbon paper and a second 12 mm segment of cellulose acetate tow. The first segment is a 8.5 inch wide carbon/tobacco paper available as P-144-BAC from Kimberly-Clark Corp., gathered using the apparatus described in Example 1 of U.S. Pat. No. 4,807,809 to Pryor, et al. and circumscribed by paper plug wrap. The second segment is triacetin plasticized cellulose acetate tow (8.0 denier per filament/40,000 total denier) circumscribed by paper plug wrap. The two segments are plug tube combined into a filter element using circumscribing paper plug wrap.

The smokable material is a blend of 17 parts flue-cured tobacco cut filler and 83 parts of another smokable filler material. The other smokable material is a cut filler material obtained by casting and drying an aqueous slurry including 5 percent sodium carboxymethylcellulose, 6 percent glycerin, and 89 percent of an agglomerated material of carbonaceous material and cal-

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cium carbonate of the type described in European Patent Application No. 419,733.

The smokable material is circumscribed by a tobacco-containing paper available as P-2249-115 from Kimberly-Clark Corp. The tobacco-containing paper is circumscribed by a paper of the type described at col. 19, lines 16–23 of European Patent Application No. 419,733.

The filter element is attached to the tobacco rod using non-porous tipping paper. The cigarette is not air diluted.

EXAMPLE 16

Cigarettes are provided as described in Example 15. However, the tobacco-containing paper inner wrap of the tobacco rod is a tobacco-containing paper available as P-2674-157 from Kimberly-Clark Corp.; and the carbon/tobacco paper of the filter element is a gathered paper containing activated coconut hull carbon and available as P-144-17AC from Kimberly-Clark Corp.

EXAMPLE 17

Cigarettes are provided as described in Example 15. However, the inner wrap of the tobacco rod is available as P-2674-157 from Kimberly-Clark Corp.; and the carbon/tobacco paper of the filter element is a gathered paper available as P-144-21AC from Kimberly-Clark Corp.

EXAMPLE 18

Cigarettes are provided as described in Example 15.However, the inner wrap of the tobacco rod is available as P-2674-157 from Kimberly-Clark Corp.; and the carbon/tobacco paper of the filter element is a gathered paper available as P-144-33AC from Kimberly-Clark Corp.

EXAMPLE 19

Cigarettes are provided as described in Example 15. However, the inner wrap of the tobacco rod is available as P-2674-157 from Kimberly-Clark Corp.; and the paper of the filter element is a gathered soft wood pulp/carbon paper having a thickness of about 0.005 inch available as P-144-50AC from Kimberly-Clark Corp.

EXAMPLE 20

Cigarettes substantially as shown in FIG. 3 are prepared as follows:

Cigarettes have rod lengths, filter element lengths and circumferences essentially equal to those of the cigarettes described in Example 15. The smokable blend also is described in Example 15. The inner wrap of the tobacco rod is a tobacco-containing paper available as P-2674-157 from Kimberly-Clark Corp. The outer wrap of the tobacco rod is available as DD-100-2 from Kimberly-Clark Corp.

The filter element includes 3 segments. The segment adjacent the tobacco rod is 7 mm long, and includes a gathered web of about 11 inch width of non-woven polyproylene fibers, which web is available as PP-100-F from Kimberly-Clark Corp. circumscribed by paper plug wrap. The center segment is 8 mm long and includes a plasticized cellulose acetate tube available from American Filtrona Corp with 60 mg of Calgon PCB carbon particles of −12/+30 U.S. mesh size positioned in the longitudinally extending passageway of about 3.2 mm diameter in that tube. The mouthend segment is 12 mm long and includes plasticized cellulose acetate tow (8 denier per filament/40,000 total denier) circumscribed by paper plug wrap.

The three filter segments are attached together by a circumscribing paper plug wrap to form a filter element. The filter element is attached to the tobacco rod using non-porous tipping paper. The cigarette is not air diluted.

EXAMPLE 21

Cigarettes substantially as shown in FIG. 1 are provided using materials as described in Example 20. However, the first filter segment is a 15 mm segment of a filter available as ACT Activated Carbon Thread Filter from American Filtrona Corp., and the second filter segment is a 12 mm segment of triacetin plasticized cellulose acetate tow (8 denier per filament/40,000 total denier) circumscribed by paper plug wrap.

EXAMPLE 22

Cigarettes substantially as shown in FIG. 1 are prepared as follows:

The cigarettes each have a length of about 84 mm and a circumference of about 24.8 mm, and include a tobacco rod having a length of about 57 mm and a filter element having a length of about 27 mm. Each filter element includes a filter segment of gathered carbon paper and a filter segment of cellulose acetate tow. The first filter segment has a length of about 15 mm, and includes carbon paper available as P-144-50AC from Kimberly-Clark Corp. gathered as described in Example 1. The second filter segment has a length of about 12 mm, and includes triacetin plasticized cellulose acetate tow (2.7 denier per filament/48,000 total denier). The filter material of each filter segment is circumscribed by paper plug wrap. The two filter segments are combined by a circumscribing paper plug wrap.

The smokable material is a blend of 85 parts flue-cured tobacco cut filler and 15 parts Samsun Oriental tobacco cut filler. The smokable material has a casing formula applied thereto in order that the cut filler blend has in contact therewith 0.35 percent licorice powder, 0.92 percent glycerine, 0.45 percent propylene glycol, 0.62 percent St. John's Bread (light roast) powder, 0.23 percent absolute cocoa from Robertet, Inc., 0.92 percent Fig Supreme Flavor from Bell Flavors, In., and 1.05 percent potassium carbonate. Then, the cased blend is volume expanded using the G-13 process of R. J. Reynolds Tobacco Company to provide a cased, puffed tobacco blend.

About 320 mg of the tobacco blend is circumscribed by a tobacco containing paper available as P-2831-189-B4-6606 from Kimberly-Clark Corp. The paper includes wood pulp as well as flue-cured, Burley and Basma Oriental tobacco pieces. The tobacco containing paper is in turn circumscribed by an outer paper wrap available as Reference No. 854 from Kimberly-Clark Corp. The resulting tobacco rod weighs about 0.54 g.

The filter element is attached to one end of the tobacco rod using circumscribing non-porous tipping paper. The cigarette is air diluted 33 percent by providing a ring of perforations about 13 mm from the extreme mouthend of the cigarette.

The cigarette yields 7.3 puffs when smoked under FTC smoking conditions.

EXAMPLE 23

Cigarettes are provided as described in Example 15. However, the outer wrap of the tobacco rod is available

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as DD-100-2 from Kimberly-Clark Corp. The inner wrap of the tobacco rod is available as P-2674-157 from Kimberly-Clark Corp., the first filter segment is a 15 mm long segment provided by gathering an 8.5 inch wide web of carbon-containing paper available as P-144-50AC from Kimberly-Clark Corp. using a rod making apparatus, the second filter segment is a 12 mm long segment of cellulose acetate tow (2.7 denier per filament/48,000 total denier), and the smokable blend is that blend described in Example 22.

EXAMPLE 24

Cigarettes are made as described in Example 1, except that the second or outer paper wrap is available as TOD 05992 from Ecusta Corp. The second or outer wrap is a heavy weight sheet, low visible sidestream paper. The base sheet contains about 15 percent calcium carbonate, about 25 percent magnesium hydroxide and about 60 percent flax fiber. The paper has an inherent permeability of about 10 CORESTA units and a basis weight of about 48 g/m^2. The paper has an aqueous solution including about 2 percent malic acid, about 2 percent potassium malate, and about 10 percent potassium chloride incorporated therein using a size press. The paper includes abut 52 mg potassium ions per gram of dry base sheet. The paper is electrostatically perforated so as to yield a net porosity of about 110 CORESTA units.

EXAMPLE 25

Cigarettes are provided as described in Example 22, using the smokable blend described in Example 22. However, the outer wrap of the tobacco rod is a paper available as TOD 05375 from Ecusta Corp.

What is claimed is:

1. A cigarette comprising (A) a smokable rod including smokable material contained in first and second circumscribing outer wrapping materials; the first wrapping material circumscribing the smokable filler material, and the second wrapping material circumscribing and overwrapping the first wrapping material; the first wrapping material including a salt additive and tobacco material; and the second wrapping material (i) including a cellulosic base web and inorganic filler material, (ii) exhibiting an inherent air permeability below about 15 CORESTA units, and (iii) exhibiting a net air permeability above about 40 CORESTA units; and (B) a filter element including a carbonaceous material.

2. The cigarette of claim 1 wherein the smokable material consists essentially of tobacco filler material.

3. The cigarette of claim 2 wherein the tobacco filler material includes casing and/or top dressing components.

4. The cigarette of claim 1 wherein the second wrapping material exhibits an inherent air permeability below about 5 CORESTA units.

5. The cigarette of claim 1 wherein the inorganic filler material of the second wrapping material includes magnesium hydroxide.

6. The cigarette of claim 1, 4 or 5 wherein the second wrapping material exhibits a net air permeability between about 50 and about 225 CORESTA units.

7. The cigarette of claim 1 wherein the salt additive of the first wrapping material includes calcium carbonate.

8. The cigarette of claim 1 or 7 wherein the salt additive of the first wrapping material includes a water soluble salt.

9. The cigarette of claim 1 wherein the first wrapping material exhibits an inherent air permeability above about 50 CORESTA units.

10. A cigarette comprising (A) a smokable rod including smokable material contained in first and second circumscribing outer wrapping materials; the first wrapping material circumscribing the smokable filler material, and the second wrapping material circumscribing and overwrapping the first wrapping material; the first wrapping material (i) including tobacco material, and (ii) exhibiting an inherent air permeability above about 50 CORESTA units; and the second wrapping material (i) including cellulosic base web and inorganic filler material, (ii) exhibiting an inherent air permeability below about 15 CORESTA units, and (iii) exhibiting a net air permeability above about 40 CORESTA units; and (B) a filter element including a carbonaceous material.

11. The cigarette of claim 10 wherein the smokable material consists essentially of tobacco filler material.

12. The cigarette of claim 10 wherein the second wrapping material exhibits an inherent air permeability below about 5 CORESTA units.

13. A cigarette comprising (A) a smokable rod including smokable material contained in first and second circumscribing outer wrapping materials; the first wrapping material circumscribing the smokable filler material, and the second wrapping material circumscribing and overwrapping the first wrapping material; the first wrapping material including a tobacco material; and the second wrapping material having a cellulosic base web and inorganic filler material; and (B) a filter element including a carbonaceous material.

14. The cigarette of claim 13 wherein the smokable material consists essentially of tobacco filler material.

15. The cigarette of claim 13 wherein the second wrapping material exhibits an inherent air permeability below about 8 CORESTA units.

16. The cigarette of claim 13 wherein the first wrapping material includes an inorganic salt additive.

17. The cigarette of claim 13 wherein the first wrapping material includes a water soluble salt additive.

18. The cigarette of claim 1, 5, 10, 13 or 16 wherein the first wrapping material includes a carbonaceous material.

19. The cigarette of claim 1, 5, 10 or 13 wherein the filter element includes about 25 mg to about 100 mg of carbonaceous material.

20. The cigarette of claim 1, 5, 10 or 13 wherein the carbonaceous material is in the form of particles.

21. The cigarette of claim 20 wherein the particles of carbonaceous material are dispersed in cellulose acetate tow.

22. The cigarette of claim 1, 4, 10 or 13 wherein the carbonaceous material has a carbon content above about 90 weight percent.

23. The cigarette of claim 1, 5, 10 or 13 wherein the carbonaceous material is activated.

24. The cigarette of claim 1, 5, 10 or 13 wherein the carbonaceous material is an activated coconut hull based carbon.

25. The cigarette of claim 1, 5, 10 or 13 wherein the filter element includes a segment including carbon-containing paper having particles of carbonaceous material therein, the paper being in gathered form.

* * * * *

United States Patent [19]

Gentry et al.

[11] Patent Number: 5,074,321

[45] Date of Patent: Dec. 24, 1991

[54] CIGARETTE

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[21] Appl. No.: 414,833

[22] Filed: Sep. 29, 1989

[51] Int. Cl.^{5} A24D 1/18

[52] U.S. Cl. 131/352; 131/355; 131/359; 131/335; 131/364; 131/336; 131/365

[58] Field of Search 131/362, 365, 359, 369, 131/334, 352, 355, 335, 364, 336

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Primary Examiner—V. Millin

[57] ABSTRACT

Cigarettes include tobacco-containing smokable material wrapped in a low porosity paper wrapper. The smokable material includes an intimate mixture of tobacco extract, pyrolyzed alpha-cellulose, agglomerated calcium carbonate particles, glycerin and carboxymethylcellulose. Such cigarettes yield low levels of incomplete combustion products and generate low levels of visible sidestream smoke.

81 Claims, 1 Drawing Sheet

EXHIBIT NO. 15
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Date: 5-21-97
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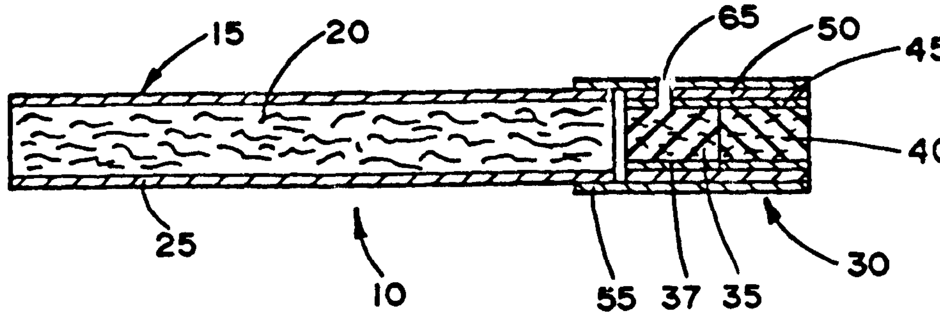

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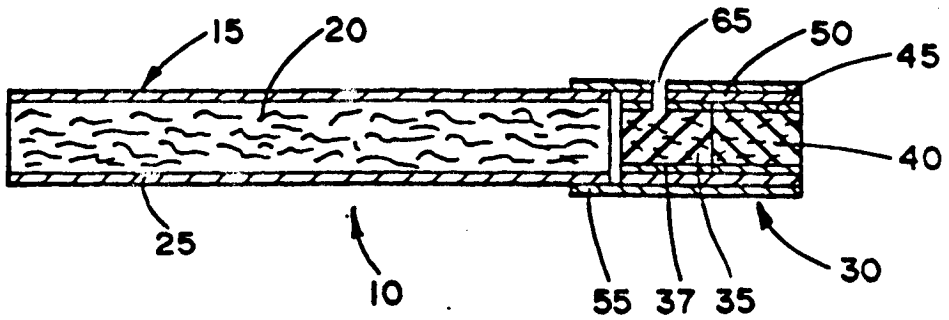

FIG. 1

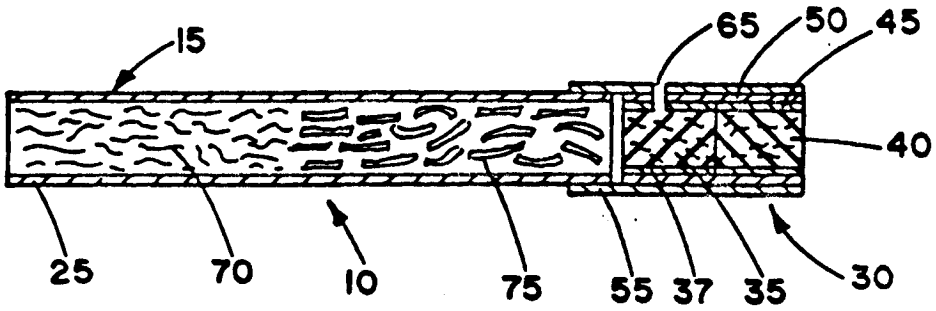

FIG. 2

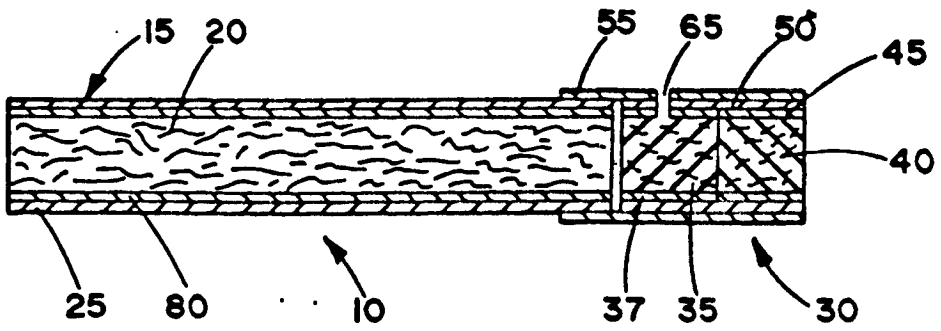

FIG. 3

CIGARETTE

BACKGROUND OF THE INVENTION

The present invention relates to smoking articles such as cigarettes, and in particular to cigarettes, which when smoked, yield relatively low levels of incomplete combustion products, generate low amounts of sidestream "tar" and odor, and sustain smolder during FTC smoking conditions.

Popular smoking articles, such as cigarettes, have a substantially cylindrical rod shaped structure and include a roll or charge of smokable material, such as shredded tobacco material (e.g., in cut filler form), wrapped in a paper wrapper, thereby forming a so-called "smokable rod". Normally, a cigarette has a cylindrical filter element aligned in an end-to-end relationship with the smokable rod. Typically, a filter element includes cellulose acetate tow circumscribed by plug wrap, and is attached to the smokable rod using a circumscribing tipping material.

Typically, cigarettes are employed by the smoker by lighting one end thereof and burning the smokable rod. As such, smoke normally is provided by burning smokable material, which typically is tobacco cut filler. The smoker then receives mainstream smoke (e.g., mainstream tobacco smoke) into his/her mouth by drawing on the opposite end (e.g., the filter end) of the cigarette. As such, the smoker is provided with the pleasures of smoking (e.g., smoking taste, feel, satisfaction, and the like).

During the time that the cigarette is burning, sidestream smoke is generated. Sidestream smoke is smoke which directly enters the atmosphere from the lit end of the cigarette. Sidestream smoke diffuses into the atmosphere, and the characteristic visible nature and odor thereof may be perceived negatively by some individuals. The relative amount of visible sidestream smoke generated by a burning cigarette is related to the amount of sidestream "tar" generated by that burning cigarette. Typical commercially available cigarettes which burn tobacco cut filler, and have lengths of about 84 mm (e.g., having a smokable rod length of about 57 mm and a filter element length of about 27 mm), often yield about 25 to about 35 mg of sidestream "tar" per cigarette. See, Proctor et al, *Analyst*, Vol. 113, p. 1509 (1988), for an apparatus and technique for determining the sidestream "tar" of a cigarette.

Numerous cigarettes which reportedly yield relatively low levels of visible sidestream smoke have been proposed. See, for example, Luke U.S. Pat. No. 4,637,410; Baker et al U.S. Pat. No. 4,624,268; Baker U.S. Pat. No. 4,407,308; Cline et al, U.S. Pat. No. 4,231,377; Cline U.S. Pat. No. 4,420,002; Owens U.S. Pat. No. 4,450,847; Martin U.S. Pat. No. 4,108,151; Cline U.S. Pat. No. 4,225,636; Cline U.S. Pat. No. 4,433,697; Mathews et al U.S. Pat. No. 4,461,311; and Guess U.S. Pat. No. 4,561,454.

Through the years, there have been proposed various methods for altering the composition of mainstream tobacco smoke. For example, many tobacco substitute materials have been proposed, and a substantial listing of such materials can be found in Rainer et al U.S. Pat. No. 4,079,742. In addition, tobacco substitute smoking materials having the tradenames Cytrel and NSM were introduced in Europe during the 1970's.

Numerous references have proposed articles which generate flavored vapor and/or visible aerosol. Most of

such articles have employed a combustible fuel source to provide an aerosol and/or to heat an aerosol forming material. See, for example, the background art cited in Banerjee et al U.S. Pat. No. 4,714,082.

Smoking articles which are capable of providing the pleasures associated with cigarette smoking, by heating but not necessarily burning tobacco, and without delivering considerable quantities of incomplete combustion products, are described in Banerjee et al U.S. Pat. No. 4,714,082; Clearman U.S. Pat. No. 4,756,318; and Sensabaugh, Jr. et al U.S. Pat. No. 4,793,365. Such smoking articles employ a combustible fuel element for heat generation; and aerosol forming substances positioned physically separate from, and in a heat exchange relationship with, the fuel element. During use, heat generated by the fuel element acts to volatilize the aerosol forming substances, thereby providing an aerosol which resembles tobacco smoke. Such smoking articles yield extremely low levels of visible sidestream smoke as well as low levels of FTC "tar".

It would be desirable to provide a good tasting cigarette which provides good smoking satisfaction, provides relatively low mainstream gas phase yields, provides relatively low levels of incomplete combustion products, sustains smolder during FTC smoking conditions, and generates low levels of sidestream "tar" and hence low levels of visible sidestream smoke.

SUMMARY OF THE INVENTION

The present invention relates to smoking articles incorporating a tobacco material. Preferred smoking articles have the form of a cigarette having two essential components: (i) a roll or charge of tobacco-containing smokable material, and (ii) an outer wrapping material (e.g., a paper wrapper) circumscribing the roll of smokable material.

The preferred wrapping material, which surrounds the roll of smokable material to thereby form a "smokable rod", is a low air permeability cigarette paper wrapper. Highly preferred wrappers having a low air permeability or low porosity exhibit a porosity below about 5 CORESTA units. A CORESTA unit is a measure of the linear air velocity which passes through a 1 cm^2 area of wrapper at a constant pressure of 1 centibar. See CORESTA Publication ISO/TC 126/SC I N159E (1986).

One form of tobacco-containing smokable material which may be incorporated into a cigarette of the present invention is a reconstituted tobacco filler material which comprises an intimate mixture of (i) tobacco material, (ii) inorganic filler having a relatively low bulk density, and optionally (iii) binding agent.

Another form of tobacco-containing smokable material which may be incorporated into a cigarette of the present invention comprises an intimate mixture of (i) tobacco material, (ii) inorganic filler, and preferably an inorganic filler having a relatively low bulk density, (iii) carbonaceous material (e.g., pyrolyzed cellulose), and (iv) binding agent. The tobacco material which is incorporated within the tobacco-containing smokable material can have the form of (i) tobacco laminae, tobacco stems and tobacco dust, as is useful in providing known types of reconstituted tobacco materials, and/or (ii) tobacco extracts. Such a smokable material also may include certain flavoring agents (e.g., cocoa, menthol, etc.) and/or aerosol forming materials (e.g., glycerin).

The previously described forms of tobacco-containing smokable materials can be employed individually or as blends thereof in manufacturing cigarettes of the present invention. Furthermore, the previously described forms of tobacco-containing smokable materials can be blended with other forms of smokable materials, such as tobacco cut filler.

Another form of smokable material which may be incorporated into a cigarette of the present invention has the form of a blend of a tobacco in smokable form (e.g., a tobacco filler material including tobacco laminae cut filler or a reconstituted tobacco filler material) and a smokable material which comprises an intimate mixture of (i) carbonaceous material (e.g., pyrolyzed cellulose), (ii) inorganic filler material, and preferably in inorganic filler having a relatively low bulk density, and (iii) binding agent. The smokable material which is blended with the tobacco filler material may include flavoring agents and/or visible aerosol forming materials.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1 through 3 are longitudinal sectional views of smoking articles of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A preferred embodiment of a cigarette of the present invention is shown in FIG. 1. The cigarette 10 includes a generally cylindrical rod 15. The rod includes a roll of smokable material 20 wrapped in at least one layer of circumscribing outer wrapping material 25 (e.g., paper). The rod 15 is hereinafter referred to as a "smokable rod". The ends of the smokable rod 15 are open to expose the smokable material. The smokable rod is used by lighting one end thereof, and smoke is provided as a result of the combustion of the burning smokable material. As such, the smokable rod burns from the lit end thereof towards the opposite end thereof.

The cigarette 10 also includes a filter element 30 positioned adjacent one end of the smokable rod 15 such that the filter element and smokable rod are axially aligned in an end-to-end relationship, preferably abutting one another. Filter element 30 has a generally cylindrical shape, and the diameter thereof is essentially equal to the diameter of the smokable rod. The ends of the filter element are open to permit the passage of air and smoke therethrough. The preferred filter element has at least two filter segments. As shown in FIG. 1, a first filter segment is positioned adjacent the smokable rod, and preferably includes a carbonaceous filter material 35 circumscribed by a wrapping material 37; while a second filter segment is positioned at the extreme mouthend of the cigarette, and preferably includes a filter material 40, such as a gathered non-woven polypropylene web or cellulose acetate tow, circumscribed by a wrapping material 45. The filter material 40 of the segment preferably is a material which provides an aesthetically pleasing, white appearance. Each of the filter segments is manufactured using known filter rod making machinery. The two segments are combined using known plug tube combining techniques, and are held together using circumscribing wrap 50 so as to form the filter element.

The filter element 30 normally is attached to the smokable rod 15 by tipping material 55, which circumscribes both the entire length of the filter element and an adjacent region of the smokable rod. The inner surface of the tipping material 55 is fixedly secured to the outer surface of the plug wrap 50 and the outer surface of the wrapping material 25 of the smokable rod, using a suitable adhesive. The cigarette 10 can be manufactured using known cigarette making techniques and equipment. Optionally, a ventilated or air diluted cigarette is provided with an air dilution means such as a series of perforations 65 which extend through the tipping material 55, plug wrap 50 and wrapping material 37. Such ventilation can be provided to the cigarette using known techniques, such as laser perforation techniques.

Another preferred embodiment of a cigarette of the present invention is shown in FIG. 2. The cigarette 10 is generally similar to the cigarette described with reference to FIG. 1, except that the smokable material has the form of a blend which is provided in a segmented fashion. At one end of the smokable rod 15 (i.e., at the end of the cigarette to be lit) is located a first segment 70 of smokable material. At the other end of the smokable rod 15 (i.e., at the filter end of the smokable rod) is located a second segment 75 of smokable material. Each segment is defined or identified in terms of its composition (i.e., the composition of each segment is different). The segments are aligned in an abutting, end-to-end relationship; however, there can be a certain amount of intermixing of smokable materials in the region where the two segments meet. The length which each segment of smokable material extends along the smokable rod can vary. However, the relative longitudinal length of the first segment relative to the second segment normally ranges from about 1:2 to about 2:1, with about 1:1 being preferred. Such smokable rods can be manufactured using apparatus described in Wahle et al U.S. Pat. No. 4,009,722 and Pinkham U.S. Pat. No. 4,516,585.

For preferred cigarettes of the type shown in FIG. 2, the first segment 70 is composed of tobacco in a smokable form. Such a form of tobacco includes tobacco laminae, processed tobacco materials, volume expanded tobacco filler, reconstituted tobacco filler materials, and the like; blends thereof; and blends thereof with other smokable materials. An example of a processed tobacco material is a deproteinated reconstituted tobacco material described in U.S patent application Ser. No. 195,985, filed May 19, 1988, now Bernasek et al U.S. Pat. No. 4,887,618, which is incorporated herein by reference. Preferred cigarettes also have a second segment 75 which includes a smokable material or blend of smokable materials different in composition from the smokable material of the first segment 70. An example of a smokable rod 15 includes a first segment 70 which includes a blend of 1 weight part deproteinated reconstituted tobacco filler material and 3 weight parts of a smokable filler material comprising an intimate mixture of carbonaceous material, calcium carbonate, glycerin and binding agent; and a second segment 75 which includes a blend of 1 weight part deproteinated reconstituted tobacco filler material and 9 weight parts of a smokable filler material comprising an intimate mixture of carbonaceous material, calcium carbonate, glycerin and binding agent.

Another preferred embodiment of a cigarette of the present invention is shown in FIG. 3. The cigarette 10 is generally similar to the cigarette described with reference to FIG. 1, except that the smokable material 20 is wrapped or contained in a processed tobacco sheet 80. The processed tobacco sheet 80 normally is a reconstituted tobacco sheet which is manufactured using a papermaking process, and a single layer of the sheet cir-

cumscribes the smokable material 20. The smokable material 20 wrapped in the processed tobacco sheet 80 is in turn wrapped in a single layer of circumscribing outer wrapping material 25 (e.g., cigarette paper).

The smokable material employed in the manufacture of the smokable rod can vary, and most preferably has the form of filler (e.g., cut filler). As used herein, the terms "filler" or "cut filler" in referring to smokable materials are meant to include smokable materials which have a form suitable for use in the manufacture of smokable rods for cigarettes. As such, filler can include smokable materials which are blended and are in a form ready for cigarette manufacture. Smokable filler materials normally are employed in the form of strands or shreds as is common in cigarette manufacture. For example, cut filler material can be employed in the form of strands or shreds from sheet-like or "strip" materials. Such strip materials are cut into widths ranging from about 1/5 inch to about 1/60 inch, preferably from about 1/30 inch to about 1/40 inch. Generally, the resulting strands or shreds have lengths which range from about 0.25 inch to about 3 inches.

One type of smokable material comprises an intimate mixture of carbonaceous material, binding agent and inorganic filler material. Such a smokable material preferably includes as part of the intimate mixture, at least one aerosol forming material and/or at least one flavoring agent. Such a smokable material normally includes about 30 to about 70, preferably about 35 to about 60 weight percent inorganic filler material; about 10 to about 60, preferably about 10 to about 30 weight percent carbonaceous material; up to about 10, preferably about 2 to about 8 weight percent binding agent; up to about 10, preferably about 3 to about 8 weight percent aerosol forming material; and sufficient amounts of flavoring agent to provide the desired flavor characteristics. Such a smokable material can be employed with (e.g., blended with) tobacco in smokable form in order to provide a cigarette of the present invention.

One type of tobacco-containing smokable material comprises an intimate mixture of tobacco material, carbonaceous material, binding agent and inorganic filler material. Such a tobacco-containing smokable material preferably includes as part of the intimate mixture, at least one aerosol forming material and/or at least one flavoring agent. Such a tobacco-containing smokable material normally includes up to about 25, typically up to about 20 weight percent tobacco material; about 30 to about 70, preferably about 35 to about 60 weight percent inorganic filler material; about 10 to about 60, preferably about 10 to about 30 weight percent carbonaceous material; up to about 10, preferably about 2 to about 8 weight percent binding agent; up to about 10, preferably about 3 to about 8 weight percent aerosol forming material; and sufficient amounts of flavoring agent to provide desired flavor characteristics.

Typically, the previously described types of smokable materials are provided by forming an aqueous slurry of the components of the smokable material, casting the slurry as a sheet, and drying the cast material to form a relatively dry workable sheet. A material such as calcium acetate or calcium hydroxide can be incorporated into the slurry. The cast material can be dried at ambient temperatures or at elevated temperatures The resulting dried sheet can be cut or broken into "strip" form, and later can be cut or shredded into cut filler form.

It is preferable to incorporate a caramelizing material into the previously described types of smokable materials. Caramelizing materials act to improve the contiguity and integrity of the ash and fire cone of the cigarette. The caramelizing material can be incorporated into the smokable material during the preparation of the smokable material and/or applied to the surface of the smokable material after the smokable material has been manufactured. Normally, the amount of caramelizing material which is employed to treat a particular smokable material is such that the resulting smokable material which incorporates the caramelizing material includes about 5 to about 20 weight parts of caramelizing material and about 80 to about 95 weight parts of the smokable material which is treated. Examples of suitable caramelizing materials include sugars, such as glucose, fructose and sucrose; and compositions such as Carob Powder Code 1739 from M. F. Neal, Inc.

The previously described types of smokable materials incorporate carbonaceous material (i.e., a material consisting primarily of carbon) therein. Such a material is a combustible material, and most preferably is derived from natural cellulosic materials. Natural cellulosic materials preferably have a high cellulose content (i.e., a cellulose content above about 80 weight percent). Examples of natural cellulosic materials include cotton fibers, cotton linters, hardwood pulp and softwood pulp. Typical combustible carbonaceous materials are provided by pyrolyzing a natural cellulosic material under inert atmosphere at temperatures between about 600° C. and about 1,200° C. Such carbonaceous materials normally exhibit a surface area of less than about 500 m^2/g, as determined using the Dubinin-Polanyi method described by Lamond and Marsh, *Carbon*, Vol. 1, p. 281 and p. 293 (1964). Such carbonaceous materials can be activated in an oxidizing environment (e.g., under carbon dioxide or steam) to increase the surface area and/or porosity thereof). Preferred combustible carbonaceous materials include at least about 80 weight percent carbon.

The previously described tobacco-containing smokable material has some form of tobacco material incorporated therein during its manufacture. The tobacco material which is employed to provide such a tobacco-containing smokable material can have a variety of forms, including tobacco extracts, tobacco dust, tobacco laminae, tobacco stems, processed tobacco filler, and the like. Tobacco extracts are provided by extracting a tobacco material using a solvent such as water, carbon dioxide, a hydrocarbon, or a halocarbon, as well as various other organic and inorganic solvents. Tobacco extracts can include spray dried extracts; tobacco essences, such as those essences described in European Patent Application No. 326,370; and aroma oils and extracts described in Mueller U.S. Pat. No. 4,506,682 and U.S. patent application Ser. No. 310,413, filed Feb. 13, 1989.

The previously described types of smokable materials incorporate a binding agent. Examples of suitable binding agents include hydroxypropylcellulose such as Klucel H from Aqualon Co.; hydroxypropylmethylcellulose such as Methocel K4MS from The Dow Chemical Co.; hydroxyethylcellulose such as Natrosol 250 MRCS from Aqualon Co.; microcrystalline cellulose such as Avicel from FMC; methylcellulose such as Methocel A4M from The Dow Chemical Co.; and carboxymethylcellulose such as CMC 7HF and CMC 7H4F from Hercules Inc. Other binding agents include

corn starch, guar gum, locust bean gum, pectins and alginates. If desired, pectin release agents (e.g., diammonium hydrogen orthophosphate) can be employed during the manufacture of the previously described reconstituted tobacco material in order to release tobacco pectins which exhibit adhesive characteristics. Combinations or blends of binding agents (e.g., a mixture of guar gum and locust bean gum) can be employed.

The previously described types of smokable materials can have at least one aerosol forming material and/or at least one flavoring agent incorporated therein. The preferred aerosol forming materials include glycerin, propylene glycol, and any other materials which yield a visible aerosol. The flavoring agents can vary, and include menthol, vanillin, citric acid, malic acid, levulinic acid, cocoa, licorice, and the like, as well as combinations thereof.

The previously described types of smokable materials incorporate inorganic filler material therein. Typical inorganic filler materials can have a fibrous, flake, crystalline, hollow or particulate form. Examples of inorganic filler material include calcium carbonate, calcium sulfate, magnesium oxide, magnesium hydroxide, perlite, synthetic mica, vermiculite, clays, thermally stable carbon fibers, zinc oxide, dawsonite, low density hollow spheres of calcium carbonate, glass spheres, glass bubbles, thermally stable carbon microspheres, calcium sulphate fibers, hollow ceramic microspheres, alumina, and the like. Desirable inorganic materials do not provide, to any significant degree, an undesirable off-taste to the mainstream cigarette smoke during use of the cigarette. Preferred inorganic materials exhibit a bulk density below about 2 g/cm^3, more preferably below about 1 g/cm^3. One preferred inorganic material has the form of glass bubbles which are available as Code 25P35 from Potter's Industries. Another inorganic material is available as Extendospheres XOL-200 from PQ Corp. A most preferred inorganic material has the form of agglomerated calcium carbonate particles.

The preferred inorganic filler material has the form of an agglomerated matrix of inorganic material. A particularly preferred inorganic filler material is agglomerated calcium carbonate, and most preferably, agglomerated precipitated calcium carbonate. Such materials are prepared by providing an aqueous slurry of calcium carbonate particles and a binding material, and drying the slurry to form an agglomerated matrix of calcium carbonate (i.e., a matrix of a plurality of calcium carbonate particles spaced within a continuous or semi-continuous phase of binding agent). Calcium carbonate particles which are employed to provide the agglomerated matrix typically exhibit a surface area of less than about 1 m^2/g, as determined using the BET method. Typical binding materials are organic materials, such as cellulosic derivatives (e.g., sodium carboxymethylcellulose), and preferably are sugar containing materials, such as molasses, high fructose corn syrup, or Carob Powder Code 1739 from M. F. Neal, Inc. Preferably, a high solids content aqueous slurry of calcium carbonate and binding material is spray dried to provide agglomerated particles (e.g., normally spherical particles) of calcium carbonate particles and binding material. Alternatively, the slurry can be dried by the application of heat to provide a solid mass of agglomerated calcium carbonate and binding material, and the solid mass can be ground to yield particles of the desired size. Preferably, the amount the calcium carbonate relative to binding material ranges from 20:1 to about 5:1, more preferably about 10:1 to about 15:1, on a dry weight basis.

The agglomerated matrix of inorganic filler material and organic binding material is subjected to heat treatment. As such, volatile components from the organic binding material are expelled, and the organic binding material is calcined to form a water insoluble, carbonaceous material. Normally, the heat treatment of the agglomerated matrix is provided under controlled atmosphere, in order to minimize or prevent oxidation of the binding material. Preferably, the heat treatment provides a binding material which is carbonaceous, and in turn, provides a means for agglomerating the inorganic filler particles into a matrix form. In particular, the agglomerated calcium carbonate and binding agent particles can be heat-treated using an oven, a fluidized bed, rotary calciners, belt calciners, or the like. For example, spray dried calcium carbonate particles agglomerated using molasses can be heated in a fluidized bed having gaseous nitrogen heated at about 300° C. to about 425° C. flowing therethrough, and collected. After the calcining process, the agglomerated calcium carbonate particles normally have a calcium carbonate content of greater than about 90 weight percent. Normally, the resulting agglomerated particles are screened to size of about −100 to +325 US Mesh. Preferred agglomerated calcium carbonate particles which have been calcined are spherical in shape, are free flowing, and exhibit a bulk density of about 0.75 g/cm^3 to about 0.95 g/cm^3. As such, agglomerated calcium carbonate particles provide an inorganic filler material having a bulk density less than about 2 g/cm^3, and preferably less than about 1 g/cm^3, which includes an inorganic material having a bulk density greater than about 2.5 g/cm^3. Normally, such agglomerated calcium carbonate particles exhibit a surface area of less than about 15 m^2/g, and often less than about 10 m^2/g, as determined using the Brunaver, Emmett and Teller (BET) method described in *J. Am. Chem. Soc.*, Vol. 60, p. 309 (1938).

Cigarettes of the present invention often include a blend of smokable materials. Preferred cigarettes include within such a blend, a sufficient amount of at least one of the previously described types of smokable materials such that the smokable material within each cigarette comprises at least about 9 percent of the carbonaceous material, based on the total weight of the blend. In particular, cigarettes having low porosity paper outer wrappers (e.g., having outer wrappers having less than about 5 CORESTA units) and having very low levels of carbonaceous material, can have the propensity to not sustain smolder (e.g., self-extinguish), when smoked under FTC smoking conditions. FTC smoking conditions consist of 35 ml puffs of 2 second duration, taken every 60 seconds. However, cigarettes having overly high levels of carbonaceous material within the smokable material can have the propensity to have overly long fire cones, especially when wrapping materials having porosities above about 3 CORESTA units are employed.

The composition of the previously described types of smokable materials can govern the quality and appearance of the ash and fire cone of the cigarette during use. To provide a cigarette having an ash and fire cone which is not overly cohesive and hence overly long, it is desirable that the smokable material comprise a sufficiently high amount of inorganic filler material. However, the amount of inorganic filler within the smokable material, and the amount of that smokable material

present within the cigarette is such that (i) the cigarette weight is not excessive (i.e., due to a high level of inorganic filler), (ii) the cigarette achieves a burn rate which is acceptable, (iii) the ash and fire cone of the cigarette exhibit good contiguity and integrity, and (iv) the cigarette provides a fire cone which is not overly long (i.e., due to a low level of inorganic filler).

Smokable materials can be cased and top dressed as is conventionally performed during various stages of cigarette manufacture. For example, flavoring agents can be applied to the smokable material as is commonly performed when cigarette cut filler is processed. Suitable flavoring agents include vanillin, cocoa, licorice, menthol, and the like. Flavor modifying agents, such as levulinic acid, can be applied to the smokable material (e.g., in amounts ranging from about 0.01 to about 2 percent, normally from about 0.1 to about 1 percent, preferably about 0.2 to about 0.6 percent, based on the dry weight of the smokable material). Aerosol forming materials, such as glycerin and propylene glycol, can be applied to the smokable material. Such components conveniently are applied to the smokable material as casing and top dressing components.

A preferred cigarette of the present invention includes (a) a tobacco-containing smokable material including at least about 90 weight percent thereof of a smokable filler material which includes an intimate mixture of (i) tobacco material, (ii) carbonaceous material, (iii) inorganic filler material, (iv) binding agent, and (v) aerosol forming material, and (b) a low porosity wrapper circumscribing the smokable material.

Yet another type of smokable material is a reconstituted tobacco material which comprises an intimate mixture of tobacco filler material, inorganic filler material having a bulk density below about 2 g/cm^3, more preferably below about 1 g/cm^3, and an optional binding agent. Such a reconstituted tobacco material normally includes about 20 to about 60 weight percent inorganic filler material, and about 40 to about 80 weight percent tobacco filler material. Examples of suitable inorganic filler materials are set forth hereinbefore with reference to the previously described smokable materials. The smokable material typically is provided by forming an aqueous slurry of the components of the smokable material, casting the slurry as a sheet, and drying the cast sheet to form a relatively dry, workable sheet. A binding agent typically is employed when the slurry of components is cast as a sheet to form the smokable material. Examples of suitable binding agents are set forth hereinbefore with reference to the previously described smokable materials. The smokable material also can be provided using a papermaking process. When a papermaking process is employed to form the reconstituted tobacco material, a binding agent typically is not employed; however, in such an instance, a small amount (e.g., up to about 5 percent, based on the dry weight of the ultimate reconstituted tobacco material) of flax fibers can be incorporated into smokable material during the preparation thereof. As used herein, the term "tobacco filler material" is meant to include natural tobacco material components, that under extraction conditions at ambient conditions using water, have a water soluble (i.e., extractable) portion and a water insoluble (i.e., non-extractable, cellulosic) portion. The tobacco filler material can be provided in the form of tobacco laminae; tobacco stems; tobacco processing by-products such as tobacco dust; processed tobacco materials including previously reconstituted tobacco materials; and the like. The tobacco type can vary, and can include flue-cured, Burley, Maryland or Oriental tobacco materials, or blends thereof.

The previously described types of smokable materials can be blended with tobacco filler materials. Such tobacco filler materials can be provided in the form of tobacco laminae; volume expanded or puffed tobacco laminae; processed tobacco stems such as cut-rolled or cut-puffed stems; reconstituted tobacco materials, such as (i) a deproteinated tobacco material described in U.S. patent application Ser. No. 195,985, filed May 19, 1988, now Bernasek et al U.S. Pat. No. 4,887,618, (ii) a phosphate-containing reconstituted tobacco material described in Hind et al U.S. Pat. Nos. 3,353,541 and 3,420,241, and Hind U.S. Pat. No. 3,386,449, or (iii) a reconstituted tobacco material described in *Tobacco Encyclopedia*, edit by Voges, p. 389, TJI (1984); or blends thereof.

The preferred wrapping material which provides the smokable rod is a cigarette wrapping material having a low air permeability value. Such a wrapping material normally has an air permeability of less than about 5 CORESTA units, often less than about 3 CORESTA units, and frequently less than about 1 CORESTA unit. Typical wrapping materials are cigarette wrapping papers. Suitable wrapping materials are cigarette paper wrappers available as DD-71-1, DD-71-6 and DD-100-2 from Kimberly-Clark Corp. Suitable low porosity cigarette paper wrappers are commercially available, and can have various levels of burn chemicals, fluxing agents, etc., incorporated therein. Particularly preferred are cigarette paper wrappers which include an amount of a polymeric film forming agent sufficient to provide a paper having the desirably low air permeability value. For example, a sufficient amount of a solution of a polymeric film forming agent can be applied to a paper wrapper. The selection of the polymeric film forming agent will be apparent to the skilled artisan.

The optional polymeric film forming agent can be applied to the paper wrapper during the manufacture of the paper, or applied as a print or paint after manufacture of the paper is complete. Typically, the film forming agent is applied to the paper as a dilute solution (e.g., at a concentration of about 0.2 to about 5 weight percent relative to the solvent) for ease of processing. The amount of film forming agent applied to the paper wrapper depends upon factors such as the permeability of the paper and the film forming capabilities of the film forming agent. Typically, the amount of film forming agents employed ranges from about 1 to about 10 percent, based on the dry weight of the paper. For example, a 5 weight percent solution of ethylcellulose in ethanol can be applied to cigarette paper using a size press, and the paper can be dried to provide a non-wetting, moisture resistant paper wrapper having a porosity of less than 1 CORESTA unit, preferably less than 0.5 CORESTA unit.

The smokable rods and the resulting cigarettes can be manufactured in any known configuration using known cigarette making techniques and equipment. Smokable rods normally include smokable material wrapped in a single layer of wrapping material, although a double layer of wrapping material can be employed.

Typically, the smokable rod has a length which ranges from about 35 mm to about 70 mm, preferably about 40 to about 60 mm; and a circumference of about 17 mm to about 27 mm, preferably about 22 mm to about 25 mm. Short smokable rods (i.e., having lengths

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from about 35 to about 50 mm) can be employed, particularly when smokable blends having a relatively high packing density are employed.

The packing density of the smokable material contained within the outer wrapping material can vary. Typical packing densities for smokable rods of cigarettes of the present invention range from about 150 to about 400 mg/cm^3. Normally, packing densities of such smokable rods range from about 200 to about 280 mg/cm^3, frequently about 250 to about 275 mg/cm^3, particularly when relatively short (i.e., less than 50 mm long) smokable rods are employed.

The cigarettes of the present invention preferably include a filter element, and most preferably a filter element having more than one segment. For example, a preferred filter element has two or more filter segments. Typically, the segments of the preferred filter elements each have lengths which ranges from about 10 mm to about 30 mm; and circumferences of about 17 mm to about 27 mm, preferably about 22 mm to about 25 mm. The plug wrap which circumscribes the filter material of each filter segment typically is a conventional paper plug wrap, and can be either air permeable or essentially air impermeable.

Preferred filter materials of one of the filter segments include carbonaceous materials (e.g., activated carbon particles, charcoal particles, or carbon paper). An example of a particularly preferred filter material is provided by gathering a carbon paper available as P-144-BAC from Kimberly-Clark Corp. Such filter materials reduce the levels of certain gas phase components from the mainstream smoke which passes to the mouth of the smoker. As such, preferred filter materials of that segment act to reduce the levels of any smoke components which may provide an off-taste to the mainstream smoke.

Preferred filter materials of another of the filter segments normally include fibrous materials. An example of a suitable filter material is a gathered nonwoven polypropylene web. A particularly preferred nonwoven polypropylene sheet-like web is available as PP-100-F from Kimberly-Clark Corp.

Another filter segment can have a filter material in the form of a gathered web of nonwoven thermoplastic (i.e., hydrophobic) fibers in intimate contact with a water soluble tobacco extract so as to provide an extract-containing filter material. A highly preferred web is a nonwoven web of polypropylene fibers available as PP 200 SD from Kimberly-Clark Corp. Such a web can be manufactured by a melt blowing process as is described in Buntin et al U.S. Pat. No. 3,849,241. Water soluble tobacco extracts are provided by extracting a tobacco material with a solvent having an aqueous character (i.e., a solvent consisting primarily of water, preferably greater than 90 weight percent water, and most preferably essentially pure water). The specific composition of the tobacco extract can vary, depending upon factors such as the type of tobacco material which is extracted and the type of extraction conditions. Extract-containing filter materials also include a minor amount of a lubricating substance, such as a polyhydric alcohol (e.g., glycerin, propylene glycol, or the like). The lubricating substance provides flexibility to the web, and provides a web which can be shaped without the application of heat. Typical extract-containing filter materials include about 5 to about 55, preferably about 10 to about 30, weight percent water soluble tobacco extract, and up to about 10 percent lubricating substance, based on the total weight of the extract-containing filter material. Typical extract-containing filter materials are manufactured by providing an aqueous mixture of extract and lubricating substance, applying the liquid to a web of nonwoven thermoplastic fibers using a rotogravure process, and drying the web. If desired, the tobacco extract can be a spray dried extract, a freeze dried extract or a tobacco essence, and in turn dissolved in water. Methods for providing and processing extracts are set forth in European Patent Application No. 326,370. Typically, the tobacco extract contained within the nonwoven thermoplastic web has a moisture content of about 5 to about 6 weight percent, although the moisture content of a particular tobacco extract can vary.

Yet another filter segment can include a tobacco paper material as the filter material. For example, a filter material can have the form of a gathered web of tobacco paper available as P144-B from Kimberly-Clark Corp.

The filter element segments suitable for use in this invention can be manufactured using known cigarette filter making techniques. Filter elements can be manufactured from carbon paper, tobacco paper and a sheet-like nonwoven polypropylene web using filter making techniques described in Pryor et al U.S. Pat. No. 4,807,809, which is incorporated herein by reference. Alternatively, particles of charcoal or activated carbon can be incorporated into the filter element using a so-called "triple filter" configuration by positioning the particles between two segments of suitable filter materials.

Preferred filter elements have minimal mainstream aerosol (i.e., smoke) removal efficiencies while maintaining the desirable draw characteristics of the cigarette. Such minimal smoke removal efficiencies are provided by "low efficiency" filter elements. Low efficiency filter elements have a minimal ability to remove mainstream smoke particulates. See, Keith in Schemeltz's *The Chemistry of Tobacco and Tobacco Smoke*, p. 157 (1972). Generally, low efficiency filter elements provide less than about 40 weight percent mainstream smoke particulate removal efficiency.

Tipping material circumscribes the filter element and an adjacent region of the smokable rod such that the tipping material extends about 3 mm to about 6 mm along the length of the smokable rod. Typically, the tipping material is a conventional paper tipping material. Tipping materials of varying porosities can be employed. For example, the tipping material can be essentially air impermeable, air permeable, or treated (e.g., by mechanical or laser perforation techniques) so as to have a region of perforations, openings or vents thereby providing a means for providing air dilution to the cigarette. The total surface area of the perforations and the positioning of the perforations along the periphery of the cigarette can be varied in order to control the performance characteristics of the cigarette.

For air diluted or ventilated cigarettes of the present invention, the amount of air dilution can vary. Preferably, the amount of air dilution for a cigarette is greater than about 25 percent, more preferably greater than about 40 percent. The upper limit for air dilution for a cigarette typically is less than about 75 percent, more frequently less than about 65 percent. As used herein, the term "air dilution" is the ratio (expressed as a percentage) of the volume of air drawn through the air dilution means to the total volume of air and aerosol

(i.e., smoke) drawn through the cigarette and exiting the extreme mouthend portion of the cigarette. See, Selke et al, *Beitr. Zur Tabak. In.*, Vol. 4, p. 193 (1978).

Cigarettes of the present invention, when smoked, generally yield less than about 20 mg, preferably less than about 10 mg of sidestream "tar" per cigarette, as determined using the apparatus and techniques described by Proctor et al, Analyst, Vol. 113, p. 1509 (1988). Such cigarettes normally provide more than about 5 puffs, preferably more than about 6 puffs per cigarette, when smoked under FTC conditions. Normally, cigarettes of the present invention provide less than about 15 puffs, and often less than about 10 puffs, when smoked under FTC conditions.

The following examples are provided in order to further illustrate the invention but should not be construed as limiting the scope thereof. Unless otherwise noted, all parts and percentages are by weight.

EXAMPLE 1

A. Preparation of a Tobacco-Containing Smokable Filler Material:

A carbonaceous material is provided as follows:

Cotton fibers (i.e., non-tobacco material) having an alpha-cellulose content greater than 90 percent are heated in a closed oven under nitrogen atmosphere. After about 2.5 hours of heating, the temperature in the oven reaches about 650° C. The temperature within the oven is held at about 650° C. for about 1 hour, while the atmosphere is maintained under nitrogen atmosphere. Then, the heating is ceased, and the temperature within the oven cools to ambient temperature in about 4 hours, while an atmosphere of nitrogen is maintained within the oven. The heated (i.e., pyrolyzed) cotton fibers are black in color, and have undergone a weight loss of about 80 percent. The pyrolyzed cotton fibers (i.e., carbonaceous material) have a carbon content of about 92 percent.

An inorganic filler material is provided as follows:

Into a low shear mixer are charged about 48 parts tap water at ambient temperature, 38 parts precipitated calcium carbonate available as Albacar 7951 from Pfizer Inc., and about 14 parts molasses. The molasses is available from Savannah Sugar Co., and has a solids/-water content of about 50:50. The resulting mixture is agitated for about 5 to about 10 minutes to provide a slurry having a solids content of about 45 percent.

The slurry is spray dried by continuously pumping the slurry at about 0.5 to about 0.8 lb./min. to a spray dryer. The spray dryer is about 3 feet in diameter, and has a height of about 5.7 feet, excluding cone, and has a Bowen SS-5J nozzle and nozzle openings of about 0.03 inch. The inlet temperature of the spray dryer is about 450° F., and the outlet temperature is about 250° F. The resulting spray dried particles have a generally spherical shape, and a moisture content of about 2 percent.

About 600 g of the spray dried particles are charged into a crucible, and the crucible is covered with aluminum foil, and placed into a furnace. The furnace then is maintained at about 350° C. for about 2 hours. The heated particles are removed from the furnace, cooled to ambient temperature, and screened to a particle size of −120 to +230 US Mesh.

The particles so collected have a light brown color, are spherical in shape, are free flowing, and resist wetting. The particles are about 93 percent calcium carbonate, and exhibit a bulk density of 0.5 g/cm^3. The particles each are an agglomerated matrix of a plurality of precipitated calcium carbonate particles spaced within a carbonaceous material.

The smokable material is provided as follows:

Into tap water at ambient temperature and maintained at high shear in a blender is charged 5.6 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules Inc. Then, 8.4 parts glycerin is charged into the mixture. After a consistent slurry is provided, 4.55 parts tobacco extract available as SwissArome Virginia from Burger & Sohn, and 3.2 parts malic acid are charged into the mixture. The tobacco extract and malic acid are provided at a concentration of about an 18 percent within an ethanol solvent. Then, 5.6 parts fructose, 2.8 parts glucose and 0.7 parts levulinic acid are charged into the mixture. The sugars and levulinic acid are provided as a solution in 35 parts hot water. Then, 32.2 parts of the previously described carbonaceous material is folded into the mixture so as to provide a thick, black slurry. Then, 73.15 parts of the previously described inorganic filler is folded into the mixture. The resulting slurry, which is an intimate mixture of the aforementioned components, has a solids content of about 30 percent, and exhibits a pH of about 6 to about 8.

The slurry is cast to a 0.03 inch thickness onto a high density polyethylene sheet and air dried. The resulting tobacco-containing smokable material is a black sheet having (i) a thickness of about 0.012 inch, (ii) a density of about 0.473 g/cm^3, (iii) a moisture content of about 6 to about 10 percent, and (iv) a flexible and pliable character. The sheet is provided in strip form, about 2 inches by about 3 inches in size. The strips are shredded at 32 cuts per inch to provide a smokable cut filler. The shreds of filler are dusted with a caramelizing material. In particular, the smokable filler is contacted with Carob Powder Code 1739 from M. F. Neal, Inc., such that about 5 percent of the resulting smokable material is caramelizing material.

B. Preparation of a Cigarette

Cigarettes substantially as shown in FIG. 1 are provided as follows:

The cigarettes each have a length of 90 mm and a circumference of 24.8 mm, and include a smokable rod having a length of 50 mm, a first filter segment having a length of 30 mm and a second filter segment having a length of 10 mm. Each filter segment is attached to each smokable rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and a 4 mm length of the smokable rod in the region adjacent the filter element. The filter elements are not ventilated.

The smokable rod includes the previously described tobacco-containing smokable material in cut filler form.

The first filter segment is provided by gathering a 11.75 inch wide web of carbon paper available as P-144-BAC from Kimberly-Clark Corp. using the filter rod forming apparatus described in Example 1 of Pryor et al U.S. Pat. No. 4,807,809. The plug wrap for the filter segment is available as Reference No. 5831 from Ecusta Corp. The first filter segment is positioned adjacent the smokable rod.

The second filter segment is provided by gathering a 11.75 inch wide web of non-woven polypropylene web available as PP-100-F from Kimberly-Clark Corp. using the filter rod forming apparatus described in Example 1 of Pryor et al U.S. Pat. No. 4,807,809. The plug wrap for the filter segment is available as Reference No. 5831 from Ecusta Corp. The second filter segment is posi-

tioned adjacent the first filter segment, at the extreme mouth end of the cigarette.

The cigarette paper wrap exhibits an air permeability of less than 1 CORESTA unit. The cigarette paper is provided by applying a 5 percent solution of ethylcellulose in ethanol to a cigarette paper wrapper available as DD-100-2 from Kimberly-Clark Corp., and drying the resulting paper. No further burn enhancing agents are incorporated into the cigarette paper.

Smokable cigarette rods are provided using known techniques. In particular, the smokable material is circumscribed by a single layer of paper wrap. The weight of the smokable material within each cigarette rod is about 0.88 g.

The cigarettes are employed by burning the smokable rod such that the smokable material within the paper wrapper burns to yield smoke. When employed, such cigarettes yield very low levels of visible sidestream smoke and essentially no sidestream odor. Cigarettes smoked and tested in this manner each yield 8.0 puffs, 18.7 mg wet total particulate matter (WTPM), 1.8 mg nicotine, 4.8 mg water and 4.8 mg glycerin, under FTC smoking conditions. The cigarettes each yield 12.1 mg FTC "tar" (of which 4.8 mg is glycerin). The cigarettes do not self-extinguish during the smolder period experienced during FTC smoking conditions.

EXAMPLE 2

A. Preparation of a Tobacco-Containing Smokable Filler Material

Into tap water at ambient temperature and maintained at high shear in a blender is charged 5.6 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules, Inc. Then, 8.4 parts glycerin is charged into the mixture. After a consistent slurry is provided, into the mixture is charged (i) 4.55 parts of the tobacco extract described in Example 1 and 3.2 parts malic acid in 35 parts ethanol; and (ii) 5.6 parts fructose, 2.8 parts glucose, 0.7 parts levulinic acid and 7.0 parts Carob Powder Code 1739 from M. F. Neal, Inc. in 50 parts hot water. Then, 32.2 parts of the carbonaceous material described in Example 1 is folded into the mixture. Then, 73.15 parts of calcium carbonate available from Georgia Marble Co. and screened to −80 to +170 US Mesh is folded into the mixture. The resulting slurry is cast to a 0.030 inch thickness onto a high density polyethylene sheet and air dried. The resulting material is a black sheet having a thickness of about 0.012 inch, a density of about 0.571 g/cm^3, and a moisture content of about 6 to about 10 percent. The sheet is cut into strip form, about 2 inches by about 3 inches in size. The strips are shredded at 32 cuts per inch, and dusted with caramelizing material, in the manner described in Example 1.

B. Preparation of a Cigarette

The cigarettes each have a length of 84 mm and a circumference of 24.8 mm, and include a smokable rod having a length of 57 mm, a first filter segment having a length of 15 mm and a second filter segment having a length of 12 mm. Each filter element is attached to each smokable rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and a 4 mm length of the smokable rod in the region adjacent the filter element. The filter elements are not ventilated.

The cigarettes are provided using the wrapping materials and filter materials described in Example 1.

The cigarettes are employed by burning the smokable rod such that the blend of smokable material within the paper wrapper burns to yield smoke. When employed, such cigarettes yield very low levels of visible sidestream smoke and essentially no sidestream odor. Cigarettes smoked and tested in this manner yield 7.3 puffs, 30.0 mg WTPM, 3.3 mg nicotine, 7.9 mg water and 4.2 mg glycerin, under FTC smoking conditions. The cigarettes each yield 18.8 mg FTC "tar" (of which 8.2 mg is glycerin). The cigarettes do not self-extinguish during the smolder period experienced during FTC smoking conditions.

EXAMPLE 3

A. Preparation of a Tobacco-Containing Smokable Material

Into tap water at ambient temperature and maintained at high shear in a blender is charged 11.8 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules Inc. Then, 20.6 parts glycerin is charged into the mixture. After a consistent slurry is provided, 7.3 parts of the tobacco extract described in Example 1 within 35 parts ethanol is charged into the mixture. Then, 85.3 parts of the carbonaceous material described in Example 1 is folded into the mixture. Then, 15.0 parts of glass bubbles available as Code 25P35 from Potter's Industries is folded into the mixture.

The resulting slurry is cast to a 0.03 inch thickness onto a high density polyethylene sheet and air dried. The resulting material has a thickness of about 0.012 inch, a density of about 0.326 g/cm^3, and a moisture content of about 6 to about 10 percent. The sheet is divided into strip form, and the resulting strips are shredded at 32 cuts per inch to provide a smokable filler.

B. Preparation of a Cigarette

A cigarette of the configuration, dimensions, components and format of the type described in Example 2 is provided, except that the smokable rod includes the smokable material described in this Example rather than the smokable material described in Example 2. The smokable rod weighs about 0.67 g.

The cigarette is employed by burning the smokable rod. The burning cigarette has a fire core which exhibits good integrity.

EXAMPLE 4

A. Preparation of a Tobacco-Containing Smokable Material

A reconstituted tobacco material is provided using a papermaking process. A blend of 80 parts flue-cured tobacco laminae, 12 parts Maryland tobacco laminae and 8 parts Oriental tobacco laminae is extracted with tap water at ambient temperature to provide an aqueous tobacco extract and a tobacco pulp. The pulp is separated from the aqueous extract, and the pulp is contacted with calcium carbonate particles available as 15M Grade from Georgia Marble Co. The tobacco pulp and calcium carbonate particles are blended together and formed into a sheet using a papermaking process, the aqueous extraction is sprayed onto the sheet, and the sheet is dried. The resulting reconstituted tobacco sheet comprises an intimate mixture of about 50 parts tobacco material and about 50 parts calcium carbonate.

B. Preparation of a Smokable Material

Into tap water at ambient temperature and maintained at high shear in a blender is charged 23 parts of the carbonaceous material described in Example 1, 4 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules, Inc., 6 parts glycerin and 67 parts of the

calcium carbonate described in Example 2. The resulting slurry is cast as a sheet and shredded as described in Example 1. The resulting shreds of filler are dusted with caramelizing material, in the manner described in Example 1, such that about 10 percent of the resulting smokable material is caramelizing material.

C. Preparation of a Cigarette

Cigarettes substantially as shown in FIG. 2 are provided as follows:

The cigarettes each have a length of 84 mm and a circumference of 24.8 mm, and include a smokable rod having a length of 57 mm, a first filter segment having a length of 15 mm and a second filter segment having a length of 12 mm. Each filter element is attached to each smokable rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and a 4 mm length of the smokable rod in the region adjacent the filter element. The filter elements are not ventilated.

The smokable rod includes a first segment which is a blend of 80 parts of the previously described reconstituted tobacco material and 20 parts of the previously described smokable material; and a second segment which consists solely of the previously described smokable material. Each segment extends about 28.5 mm along the length of the smokable rod.

The remaining configuration, dimensions, components and format are of the type described in Example 2. The cigarettes are smoked, and yield 12.6 puffs, 34.2 mg WTPM, 1.1 mg nicotine, 8.9 mg water, and each yield 24.2. mg FTC "tar" (of which 5.0 mg is glycerin).

EXAMPLE 5

A. Preparation of Smokable Materials

Into tap water at ambient temperature and maintained at high shear in a blender is charged 23 parts of the carbonaceous material described in Example 1, 4 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules, Inc., 6 parts glycerin and 67 parts of the calcium carbonate described in Example 2. The resulting slurry is case as a sheet and shredded as described in Example 1. The resulting shreds of filler are dusted with caramelizing material, in the manner described in Example 1, such that about 10 percent of the resulting smokable material is caramelizing material.

A reconstituted tobacco material in sheet form is provided using a papermaking process. A blend of 75 parts Burley tobacco laminae and 25 parts flue-cured tobacco laminae is extracted with tap water at ambient temperature to provide an aqueous tobacco extract and a tobacco pulp. The pulp is separated from the aqueous extract, and the pulp is formed into a sheet using a papermaking process. The aqueous extract is sprayed onto the sheet, and the sheet is dried so as to have a thickness which approximates aged tobacco laminae.

B. Preparation of a Cigarette

Cigarettes substantially as shown in FIG. 3 are provided as follows:

The cigarettes each have a length of 84 mm and a circumference of 24.8 mm, and include a smokable rod having a length of 57 mm, a first filter segment having a length of 15 mm and a second filter segment having a length of 12 mm. Each filter element is attached to each smokable rod using nonporous tipping paper. For each cigarette, the tipping paper circumscribes the filter element and a 4 mm length of the smokable rod in the region adjacent the filter element.

The filter elements are provided using the wrapping materials and filter materials described in Example 1. However, for each cigarette, the smokable cut filler material is circumscribed by the previously described reconstituted tobacco material. In particular, a sheet of the reconstituted tobacco material having a length of about 57 mm and a width of about 25 mm is wrapped around the smokable filler material to provide a cylindrical rod. The smokable filler material within each rod weighs about 0.8 g and the reconstituted tobacco sheet within each rod weighs about 0.2 g. The resulting rod is in turn circumscribed by a cigarette paper wrap available as DD-100-2 from Kimberly-Clark Corp.

The cigarettes are employed by burning the smokable rod such that the smokable material within the paper wrapper burns to yield smoke. Cigarettes smoked and tested in this manner each yield 14.5 puffs, 49.7 mg WTPM, 1.4 mg nicotine, 18.3 mg water and 10.6 mg glycerin, under FTC smoking conditions. The cigarettes each yield 30 mg FTC "tar" (of which 10.6 g is glycerin). On a per-puff basis, the cigarettes yield relatively low levels of combustion-derived FTC "tar."

EXAMPLE 6

The components used to provide the cigarette described in Example 5 are used to provide a cigarette having a configuration substantially as shown in FIG. 1. In particular, 0.8 g of the smokable cut filler material is blended with 0.2 g of the reconstituted tobacco material which has been shredded at 32 cuts per inch to provide a reconstituted tobacco cut filler. The cigarettes then are provided using the wrapping materials and filter materials described in Example 5.

The cigarettes are employed by burning the smokable rod such that the smokable material within the paper wrapper burns to yield smoke. Cigarettes smoked and tested in this manner each yield 13 puffs, 40.2 mg WTPM, 2.2 mg nicotine, 10.5 mg water and 7.5 mg glycerin, under FTC smoking conditions. The cigarettes each yield 27.5 mg FTC "tar" (of which 7.5 mg is glycerin).

EXAMPLE 7

A smokable material is provided as follows:

Into 220 parts tap water at ambient temperature and maintained at high shear in a blender is charged 2.5 parts sodium carboxymethylcellulose available as CMC 7H4C from Hercules, Inc., 6 parts glycerin, 61.75 calcium carbonate from Georgia Marble Co. and screened to −80 to +170 US Mesh, and 30 parts of the carbonaceous material described in Example 1.

The resulting slurry is cast as a sheet, and dried to provide a sheet having a thickness of about 0.0166 inch.

EXAMPLE 8

A smokable material is provided as follows:

Into 200 parts tap water at ambient temperature and maintained at high shear in a blender is charged 2.6 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules, Inc., 1.4 parts guar gum, 6 parts glycerin, 67 parts calcium carbonate as described in Example 7, and 23 parts carbonaceous material described in Example 1.

The resulting slurry is cast as a sheet, and dried to provide a sheet having a thickness of about 0.0174 inch.

EXAMPLE 9

A smokable material is provided as follows:

Into 200 parts tap water at ambient temperature and maintained at high shear in a blender is charged 2 parts sodium carboxymethylcellulose available as CMC 7HF from Hercules, Inc., 2 parts hydroxypropylcellulose available as Klucel H from Aqualon Co., 6 parts glycerin, 67 parts calcium carbonate described in Example 7, and 23 parts carbonaceous material described in Example 1.

The resulting slurry is cast as a sheet, and dried to provide a sheet having a thickness of about 0.0147 inch.

EXAMPLE 10

A cigarette substantially as shown in FIG. 2, and having the format and components substantially as described in Example 4 is provided. However, the reconstituted tobacco material employed to provide such a cigarette incorporates about 40 parts of the agglomerated matrix of calcium carbonate particles within a carbonaceous material, and about 60 parts tobacco material. The agglomerated calcium carbonate particles are described in Example 1; and the reconstituted tobacco material is provided using a papermaking process.

EXAMPLE 11

A cigarette substantially as described in Example 1 is provided. However, the smokable material thereof is prepared as follows:

Into about 300 parts of an aqueous tobacco extract (about 5 to about 10 percent dissolved tobacco solids in water) at ambient temperature and maintained at high shear in a blender is charged about 5.6 parts of the sodium carboxymethylcellulose described in Example 1. Then, about 8.4 parts glycerin is charged into the mixture. After a consistent slurry is provided, 5.6 parts fructose and about 2.8 parts glucose are charged into the mixture. The sugars are provided in a solution in about 35 parts hot water. Then, about 32.2 parts of the carbonaceous material described in Example 1 is folded into the mixture. Then, about 73.2 parts of the inorganic filler described in Example 1 is folded into the mixture. The resulting slurry is cast as a sheet and air dried.

EXAMPLE 12

A smokable material is provided as follows:

Into about 200 parts tap water at ambient temperature and maintained at high shear in a blender is charged about 11.7 parts methylcellulose available as Methocel A4M from The Dow Chemical Co., about 6 parts of malic acid in about 54 parts water, about 9.8 parts glycerin, about 77 parts calcium carbonate as described in Example 7, about 7 parts of the tobacco extract described in Example 1, and about 40.6 parts carbonaceous material described in Example 1.

The resulting slurry is cast as a sheet, and dried at above 45° C. to provide a smokable sheet.

What is claimed is:

1. A cigarette comprising:

(a) a tobacco-containing smokable material including at least about 90 weight percent thereof of a smokable filler material which includes an intimate mixture of (i) up to about 25 weight percent tobacco material, (ii) about 10 to about 30 weight percent carbonaceous material, (iii) about 30 to about 70 weight percent inorganic filler material, (iv) up to about 10 weight percent binding agent, and (v) up to about 10 weight percent aerosol forming material; and

(b) a wrapping material circumscribing the smokable material and having a porosity of less than about 5 CORESTA units.

2. The cigarette of claim 1 wherein the smokable material includes up to about 10 weight percent thereof of tobacco cut filler material.

3. The cigarette of claim 1 or 2 wherein the tobacco material has the form of a tobacco extract.

4. The cigarette of claim 1 wherein the wrapping material has a porosity of less than about 1 CORESTA unit.

5. The cigarette of claim 1 or 4 wherein the wrapping material includes a polymeric agent in an amount sufficient to provide a moisture resistant character to the wrapping material.

6. The cigarette of claim 5 wherein the polymeric agent includes ethylcellulose.

7. The cigarette of claim 1 wherein the aerosol forming material of the smokable filler material includes a polyhydric alcohol.

8. The cigarette of claim 1 or 4 wherein the inorganic filler material of the smokable filler material includes particles of calcium carbonate.

9. The cigarette of claim 1 wherein the carbonaceous material of the smokable filler material includes pyrolyzed cellulose.

10. The cigarette of claim 1 wherein the carbonaceous material of the smokable filler material includes pyrolyzed alpha-cellulose.

11. The cigarette of claim 1 wherein the binding agent of the smokable filler material includes hydroxypropylcellulose.

12. The cigarette of claim 1 wherein the binding agent of the smokable filler material includes carboxymethylcellulose.

13. The cigarette of claim 1 wherein the smokable filler material has a caramelizing material incorporated therein.

14. The cigarette of claim 1 wherein the caramelizing agent includes a mixture of glucose and fructose.

15. The cigarette of claim 1 wherein the binding agent includes methylcellulose.

16. The cigarette of claim 1 wherein the inorganic filler material is an agglomerated matrix having particles of inorganic filler material spaced within a continuous or semi-continuous phase of a carbonaceous binding material.

17. A cigarette comprising:

(a) a tobacco-containing smokable material including at least about 90 weight percent thereof of a smokable filler material which includes an intimate mixture of (i) tobacco material, (ii) carbonaceous material, (iii) inorganic filler material including particles of agglomerated calcium carbonate, (iv) binding agent, and (v) aerosol forming material; and

(b) a wrapping material circumscribing the smokable material and having a porosity of less than about 5 CORESTA units.

18. A cigarette comprising:

(a) a tobacco-containing smokable material including at least about 90 weight percent thereof of a smokable filler material which includes an intimate mixture of (i) tobacco material, (ii) carbonaceous material, (iii) inorganic filler material including particles of calcium carbonate, and the surface area of the inorganic filler material is less than about 1 m^2/g. (iv) binding agent, and (v) aerosol forming material; and

(b) a wrapping material circumscribing the smokable material and having a porosity of less than about 5 CORESTA units.

19. The cigarette of claim 18 wherein the wrapping material has a porosity of less than about 1 CORESTA unit.

20. A cigarette comprising:

(a) a tobacco-containing smokable material including at least about 90 weight percent thereof of a smokable filler material which includes an intimate mixture of (i) tobacco material, (ii) carbonaceous material, (iii) inorganic filler material including particles of agglomerated calcium carbonate, and the surface area of the agglomerated calcium carbonate particles is less than about 15 m^2/g, (iv) binding agent, and (v) aerosol forming material; and

(b) a wrapping material circumscribing the smokable material and having a porosity of less than about 5 CORESTA units.

21. A cigarette comprising:

(a) a tobacco-containing smokable material including at least about 90 weight percent thereof of a smokable filler material which includes an intimate mixture of (i) tobacco material, (ii) carbonaceous material, (iii) inorganic filler material including particles of agglomerated calcium carbonate each including a matrix of calcium carbonate particles within a calcined sugar, (iv) binding agent, and (v) aerosol forming material; and

(b) a wrapping material circumscribing the smokable material and having a porosity of less than about 5 CORESTA units.

22. The cigarette of claim 21 including up to about 25 weight percent tobacco material, about 10 to about 30 weight percent carbonaceous material, about 30 to about 70 weight percent inorganic filler material, up to about 10 weight percent binding agent, and up to about 10 weight percent aerosol forming material.

23. The cigarette of claim 22 wherein the inorganic filler material of the smokable filler material includes particles of agglomerated calcium carbonate.

24. The cigarette of claim 23 wherein the particles of agglomerated calcium carbonate each include a matrix of calcium carbonate particles within a calcined sugar.

25. The cigarette of claim 17, 20 or 23 wherein the particles of agglomerated calcium carbonate are particles of calcium carbonate spaced with a continuous or semi-continuous phase of a carbonaceous binding material.

26. A cigarette comprising:

(a) a tobacco-containing smokable material including at least about 90 weight percent thereof of a smokable filler material which includes an intimate mixture of (i) tobacco material, (ii) carbonaceous material, having a surface area of less than about 30 m^2/g, (iii) inorganic filler material, (iv) binding agent, and (v) aerosol forming material; and

(b) a wrapping material circumscribing the smokable material and having a porosity of less than about 5 CORESTA units.

27. A cigarette comprising:

(a) a tobacco-containing smokable material including at least about 90 weight percent thereof of a smokable filler material which includes an intimate mixture of (i) tobacco material, (ii) carbonaceous material, (iii) inorganic filler material having a bulk density of less than about 2 g/cm^3, (iv) binding agent, and (v) aerosol forming material; and

(b) a wrapping material circumscribing the smokable material and having a porosity of less than about 5 CORESTA units.

28. The cigarette of claim 27 wherein the inorganic filler material of the smokable filler material has a bulk density of less than about 1 g/cm^3.

29. A combustible tobacco-containing smokable filler material comprising an intimate mixture of (i) tobacco material, (ii) carbonaceous material, (iii) binding agent, and (iv) an agglomerated inorganic filler material having a bulk density of less than about 2 g/cm^3 and including an inorganic material having a bulk density of greater than about 2.5 g/cm^3.

30. The smokable filler material of claim 29 wherein the inorganic material includes calcium carbonate.

31. The smokable filler material of claim 29 or 30 wherein the agglomerated inorganic filler material has a bulk density of less than about 1 g/cm^3.

32. The smokable filler material of claim 29 wherein the tobacco material has the form of a tobacco extract.

33. The smokable material of claim 29 wherein the carbonaceous material includes pyrolyzed alpha-cellulose.

34. The smokable material of claim 29 further comprising an aerosol forming material.

35. The smokable material of claim 34 wherein the aerosol forming material includes a polyhydric alcohol.

36. The smokable filler material of claim 34 including up to about 25 weight percent tobacco material, about 10 to about 30 weight percent carbonaceous material, about 30 to about 70 weight percent inorganic filler material, up to about 10 weight percent binding agent, and up to about 10 weight percent aerosol forming material.

37. The smokable material of claim 29, 30, 32, 33, 34 or 29 further comprising a caramelizing material incorporated therein.

38. The smokable filler material of claim 29 or 34 wherein the agglomerated inorganic filler material is an agglomerated matrix having particles of inorganic filler material spaced within a continuous or semi-continuous phase of a carbonaceous binding material.

39. A cigarette comprising:

(a) a tobacco-containing smokable filler material which includes an intimate mixture of (i) tobacco material, (ii) carbonaceous material, (iii) binding agent, (iv) aerosol forming material, and (v) inorganic filler material having a bulk density of less than about 2 g/cm^3 and including an inorganic material having a bulk density of greater than about 2.5 g/cm^3; and

(b) a wrapping material circumscribing the smokable material.

40. The cigarette of claim 39 wherein the tobacco material has the form of a tobacco extract.

41. The cigarette of claim 39 wherein the wrapping material is a paper having a porosity of less than about 5 CORESTA units.

42. The cigarette of claim 39 wherein the wrapping material is a paper having a porosity of less than about 1 CORESTA unit.

43. The cigarette of claim 39, 40, 41 or 42 wherein the smokable filler material further includes an aerosol forming material.

44. The cigarette of claim 43 wherein the inorganic filler material includes particles of agglomerated calcium carbonate.

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45. The cigarette of claim 44 wherein the particles of agglomerated calcium carbonate are particles of calcium carbonate spaced with a continuous or semi-continuous phase of a carbonaceous binding material.

46. The cigarette of claim 39, 40, 41 or 42 wherein the inorganic filler material includes particles of agglomerated calcium carbonate.

47. The cigarette of claim 46 including up to about 25 weight percent tobacco material, about 10 to about 30 weight percent carbonaceous material, about 30 to about 70 weight percent inorganic filler material, up to about 10 weight percent binding agent, and up to about 10 weight percent aerosol forming material.

48. The cigarette of claim 46 wherein the particles of agglomerated calcium carbonate are particles of calcium carbonate spaced with a continuous or semi-continuous phase of a carbonaceous binding material.

49. The cigarette of claim 46 wherein the particles of agglomerated calcium carbonate each include a matrix of calcium carbonate particles within a calcined sugar.

50. The cigarette of claim 39, 40, 41 or 42 wherein the smokable filler material has a caramelizing material incorporated therein.

51. The cigarette of claim 43 wherein the smokable filler material has a caramelizing material incorporated therein.

52. The cigarette of claim 39 including up to about 25 weight percent tobacco material, about 10 to about 30 weight percent carbonaceous material, about 30 to about 70 weight percent inorganic filler material, up to about 10 weight percent binding agent, and up to about 10 weight percent aerosol forming material.

53. A cigarette comprising:

(a) smokable material including a reconstituted tobacco material which includes an intimate mixture of (i) tobacco material, and (ii) an inorganic filler material having a bulk density of less than about 2 g/cm^3 and including an inorganic material having a bulk density of greater than about 2.5 g/cm^3; and

(b) a wrapping material circumscribing the smokable material.

54. The cigarette of claim 53 wherein wrapping material is a paper having a porosity of less than about 5 CORESTA units.

55. The cigarette of claim 53 wherein wrapping material is a paper having a porosity of less than about 1 CORESTA unit.

56. The cigarette of claim 53, 54 or 55 wherein the reconstituted tobacco material further includes a binding agent.

57. The cigarette of claim 56 wherein the inorganic filler material of the reconstituted tobacco material includes particles of agglomerated calcium carbonate.

58. The cigarette of claim 57 wherein the particles of agglomerated calcium carbonate each include a matrix of calcium carbonate within a calcined sugar.

59. The cigarette of claim 56 wherein the inorganic filler material of the reconstituted tobacco material includes particles of agglomerated calcium carbonate, and the particles of agglomerated calcium carbonate are particles of calcium carbonate spaced with a continuous or semi-continuous phase of a carbonaceous binding material.

60. The cigarette of claim 53, 54 or 55 wherein the inorganic filler material of the reconstituted tobacco material includes particles of agglomerated calcium carbonate.

61. The cigarette of claim 60 wherein the particles of agglomerated calcium carbonate each include a matrix of calcium carbonate within a calcined sugar.

62. The cigarette of claim 53 wherein the reconstituted tobacco material includes about 20 to about 60 weight percent inorganic filler material and about 40 to about 80 weight percent tobacco filler material.

63. A cigarette comprising:

(a) a first smokable material including a smokable filler material which includes an intimate mixture of (i) carbonaceous material, (ii) inorganic filler material, and (iii) binding agent;

(b) a second smokable material having the form of a reconstituted tobacco sheet material circumscribing and wrapping the first smokable material; and

(c) a wrapping material having a porosity of less than about 5 CORESTA units circumscribing the first and second smokable materials.

64. The cigarette of claim 63 wherein the first smokable material includes tobacco cut filler.

65. The cigarette of claim 63 wherein the first smokable material includes a smokable filler material which further includes tobacco material.

66. The cigarette of claim 63 wherein the first smokable material includes a smokable filler material which further includes aerosol forming material.

67. The cigarette of claim 63 wherein the first smokable material includes a smokable filler material which further includes tobacco material and aerosol forming material.

68. The cigarette of claim 65 or 67 wherein the tobacco material of the first smokable material has the form of a tobacco extract.

69. The cigarette of claim 63 wherein the wrapping material has a porosity of less than about 5 CORESTA units.

70. The cigarette of claim 60 wherein the particles of agglomerated calcium carbonate are particles of calcium carbonate spaced with a continuous or semi-continuous phase of a carbonaceous binding material.

71. The cigarette of claim 63 wherein the inorganic filler material of the first smokable material is an agglomerated matrix having particles of inorganic filler material spaced within a continuous or semi-continuous phase of a carbonaceous binding agent.

72. The cigarette of claim 63 wherein the inorganic filler material of the first smokable material is an agglomerated matrix having particles of calcium carbonate spaced within a continuous or semi-continuous phase of a carbonaceous binding agent.

73. A cigarette having in combination (i) a smokable rod having smokable filler material wrapped in a circumscribing wrapping material, and having the ends thereof open to expose the smokable material, and (ii) a filter element axially aligned in an end-to-end relationship adjacent one end of the smokable rod;

(a) the smokable rod having two segments of smokable filler material therewithin, each segment being defined by its composition, wherein (i) the first segment is disposed at the end of the smokable rod which is to be lit, (ii) the second segment is disposed at the end of the smokable rod adjacent the filter element, and (iii) the first and second segments are aligned in an essentially abutting, end-to-end relationship: and

(b) the first segment includes tobacco in smokable form; and

(c) the second segment includes a smokable filler material including an intimate mixture of (i) carbonaceous material, (ii) inorganic filler material, and (iii) binding agent.

74. The cigarette of claim 73 wherein the wrapping material has a porosity of less than about 5 CORESTA units.

75. The cigarette of claim 73 wherein smokable filler material of the second segment includes an intimate mixture of (i) carbonaceous material, (ii) inorganic filler material, (iii) binding agent, and (iv) aerosol forming material.

76. The cigarette of claim 73 wherein smokable filler material of the second segment includes an intimate mixture of (i) carbonaceous material, (ii) inorganic filler material, (iii) binding agent, (iv) aerosol forming material, and (v) tobacco material.

77. The cigarette of claim 73 wherein the first segment includes tobacco cut filler.

78. The cigarette of claim 73 or 76 wherein the smokable filler material of the first segment is blended with a smokable filler material which includes an intimate mixture of (i) carbonaceous material, (ii) inorganic filler material, and (iii) binding agent.

79. The cigarette of claim 73 or 74 wherein the smokable filler material of the first segment is blended with a smokable filler material which includes an intimate mixture of (i) carbonaceous material, (ii) inorganic filler material, (iii) binding agent, and (iv) aerosol forming material.

80. The cigarette of claim 73, 75 or 76 wherein the smokable filler material of the first segment includes reconstituted tobacco material.

81. The cigarette of claim 73 or 74 wherein the longitudinal length of the first segment relative to that of the second segment ranges from about 1:2 to about 2:1.

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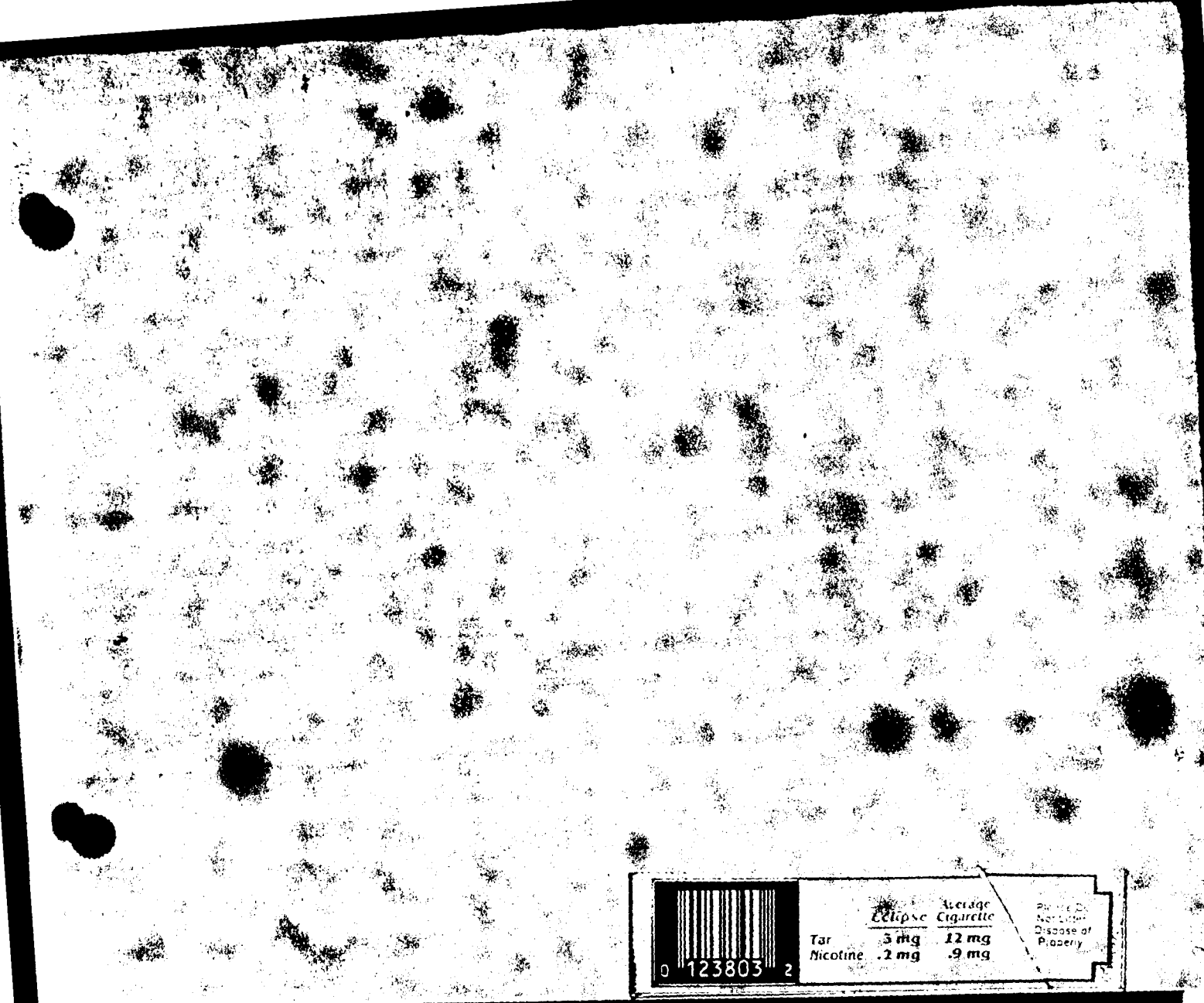

EXHIBIT NO. 16
Wit: GENTRY
Date: 5-21-97
Rptr: BD

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